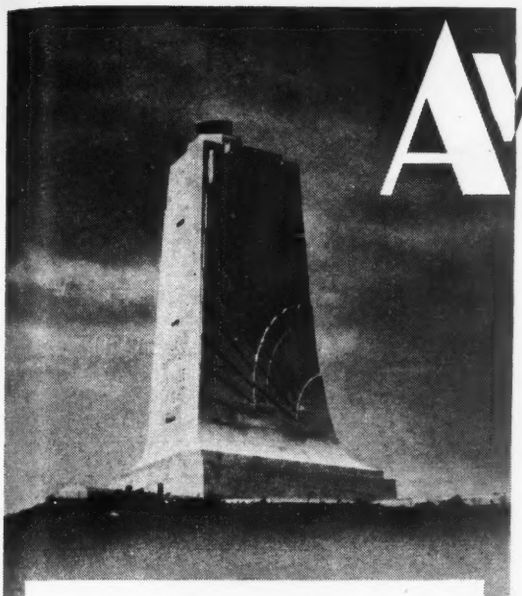

AVIATION

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On Leave of Absence With Government Services
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Aviation is indexed in Readers' Guide to Periodical Literature and in Industrial Arts Index.

More aircraft land on Goodyear tires than on any other kind!

Goodyear, Aviation Products Division, Akron 16, Ohio
Los Angeles 54, California

GOODYEAR
AVIATION
PRODUCTS

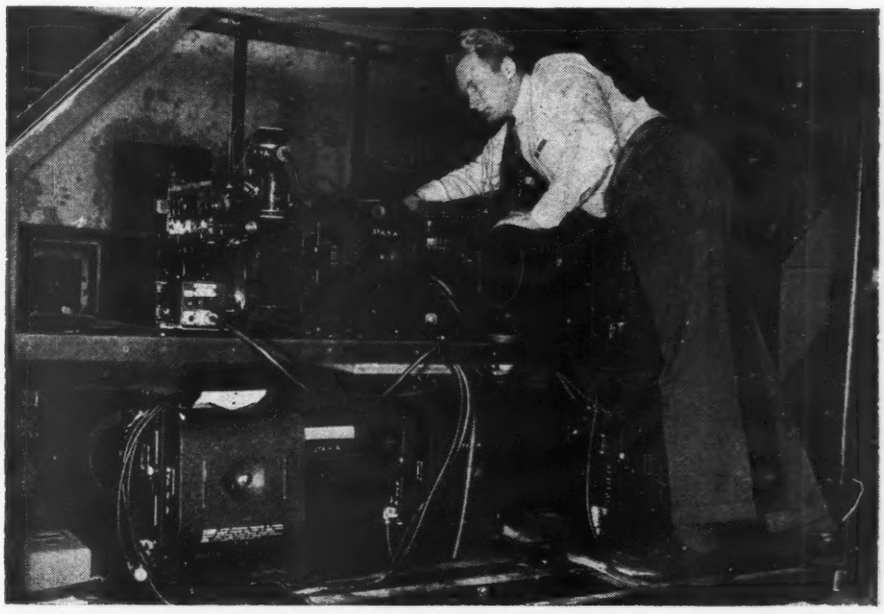
Just a year ago this month we started what we believed to be "one of the most important and valuable aircraft design presentations it has ever been our pleasure to present"—meaning Ralph Upson's series, "Designing Tomorrow's Personal Airplane." The reception accorded these special articles proved our belief—and generated a demand for more.

So, beginning on page 55 of this issue, we take just as much pride in presenting the first of a new Upson series—"Simplifying Personal Plane Design." In these articles, Mr. Upson will cover the problems of "proportioning and degree," those tough ones which often present hard-to-make choices in such vital factors as performance, range, wing loading, aspect ratio, stability and control, and landing and takeoff characteristics. And, to make it absolutely complete, he will present each month sound, practical formulas—some never published before—which can be used as everyday tools to solve the problems of design work.

It wasn't till after VE-Day that the Allies could find out what progress—if any—the Germans had made with helicopters. It was then learned that they hadn't been neglecting rotary wing craft, as is shown by the Flettner Fell-282, their most advanced job and the one which had been extensively flight tested, including operations in gusty winds and blind flying. Just how far along the Nazis were is shown in our detailed article on the Fl-282 (beginning on page 60) which delves into not only the craft's engineering features but its flight characteristics as well.

The turbojet boys are still at it—something new every month. This time we give the details on the Metropolitan-Vickers F/3, an axial-flow job with thrust augmentation that gets specific fuel consumption down to 0.65. It's a most intriguing design—2-stage turbine driving the compressor and two 2-stage contra-rotating turbines driving two contra-rotating fans for the thrust augmentation. This article is on pages 66 and 67.

We're more than a little proud to announce a change in our radio section. Now that it's possible to give some of the necessary details, we are broadening this section to embrace all angles under the head, Aviation Electronics (page 52). Here, the month's outstanding developments will get regular space. To assure the best and most accurate coverage, we have arranged to have the section conducted by Frank Rockett, Associate Editor of McGraw-Hill's leader in the field, "Electronics."



THIS SHIELD-FITTED BATTERY of Fairchild cameras—along with many others—will be radio-controlled to record the forthcoming atom bomb test at Bikini Atoll. Properly called one of the most far-reaching experiments ever conducted by man this A-bomb test is predicated upon aviation, and it will be highly influential in charting the future course of military aeronautics. To give you a complete picture of the aviation aspects of this transcendental event, Associate Editor Herb Powell has prepared (page 38) a penetrating preview of the highly complex and fascinating plans for Operation Crossroads. (Press Assn. photo)

Down the Years in AVIATION'S Log

25 Yr. Ago (1921)—Ralph Upson wins National Balloon Race traveling 425 mi. . . . . Navy bombs warships in test. . . . Bert Hathaway of U. of Cal. is first college student to fly to classes. . . . . Army organizes 1st Provisional Air Brigade combining all flying branches. . . . Dornier builds DoCS-II, cabin flying boat. . . . Two Navy HS-2L flying boats ride out heavy storm at anchor for two days. . . . Dayton-Wright wins Navy award of $16,000 for shipboard aircraft design. . . . There are now 31 aircraft manufacturers with 250% increase in business during last 5 yr.

15 Yr. Ago (1931)—Twenty-six airlines carried 11,504 passengers in month. . . . James G. Ray lands autogiro on White House lawn. . . . French air budget is $88,000,000 for year. . . . Junkers develops commercial aircraft Diesel engine. . . . Legislation calls for Board of Health inspection of planes flying from plague-harboring countries. . . . Japanese-built dirigible makes endurance record of 60 hr. without refueling. . . . Army consolidates all Air Corps schools at Randolph Field. . . . French Pilots Froton and Lavergne fly lightplane 2,153 mi. in 29 hr. 38 min., breaking record. . . . Navy orders 30 Helldivers from Curtiss for $440,000.

10 Yr. Ago (1936)—Langley Field installs 500 mph. wind tunnel. . . . Coffee manufacturer uses Bellanca Airbus for regular deliveries to distant points. . . . Navy experiments with oxygen for high-flying pilots. . . . Zeppelin Hindenburg completes first non-stop trans-Atlantic trip to Lakehurst. . . . Air express volume goes up 68% in year. . . . C&S specifies Lockheed Electras for its services. . . . Taylorcraft places first model on market. . . . Stinson reports $1¼ million business for current year. . . . Congress passes Naval appropriation of $27,000,000.

The Cessna instrument panel with complete instrumentation and radio

The new all-metal Cessnas — with their four and one-half hour cruising range and super-comfortable cabin appointments invite cross country enthusiasts. The allure is made complete by the featuring of famous Kollsman Scout flight instruments as standard. For it is the accuracy and dependability of such instruments that makes cross country flying practical and enjoyable.

The new Cessnas are equipped with an indirectly lighted, shock-mounted instrument panel bearing the Scout airspeed indicator and Scout standard altimeter as standard equipment and with the Scout sensitive altimeter and Scout vertical speed indicator optional. The latter two, as well as a turn and bank indicator, can be added to the basic group at any time.

Scout instruments are getting more than one post-war plane off to a good start. They are precise and rugged, yet are priced within the reach of any private plane owner who wants to get the most out of his plane.

Write today for complete information on these instruments to Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

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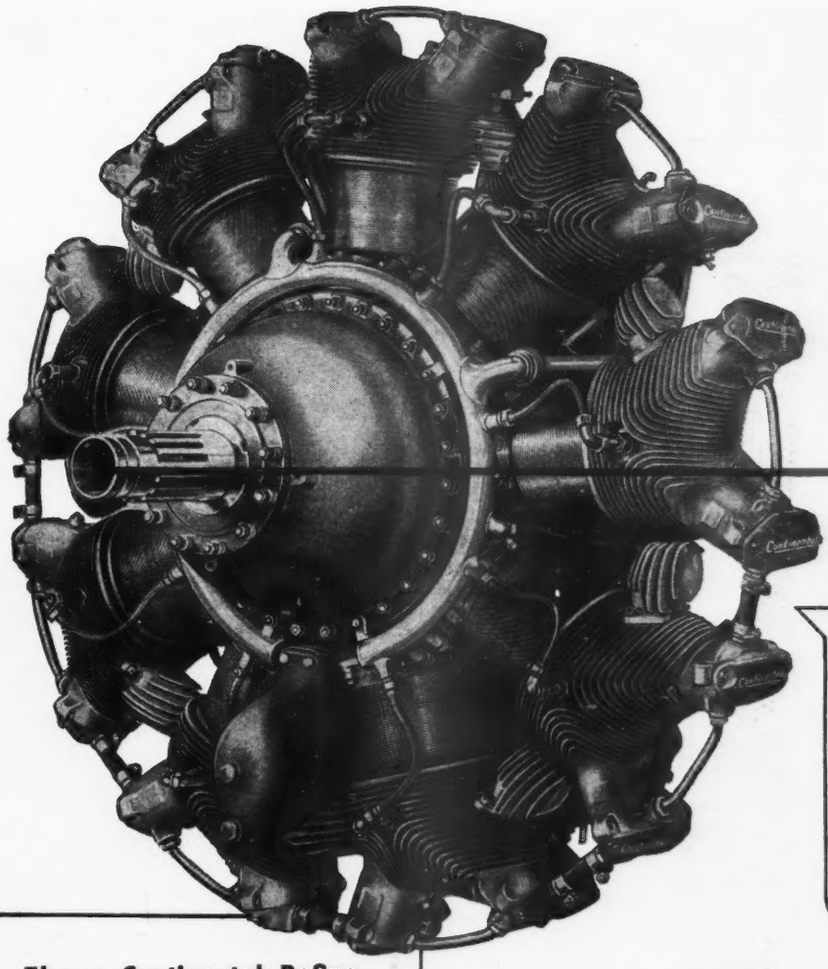


The New Continental GR-9A

9-cylinder Radial Engine for Feeder-line and Executive Type Aircraft

POWER BY

Red Seal Engines

CONTINENTAL

These Continental Refinements Mean Greater Power, Economy and Dependability, as well as Longer Life:

- Increased cooling fin area on cylinder heads and barrels.
- Enlarged supercharger impeller and re-designed supercharger entrance and diffuser passages.
- Complete force-feed lubrication to valve gear.
- Propeller reduction gear (on GR-9A model).
- Crankshaft has been re-designed and is nitrided.
- New pressure-type (injector) carburetor.
- New "Silver grid" crankpin bearings.
- Improved generator drive.
- Flexible engine mounting pads.
- Enlarged oil passages to crankshaft.
- Oil pump completely re-designed for greater capacity.
- All main castings re-designed for higher loading.

SKYPOWER FOR THE AGE OF AIR

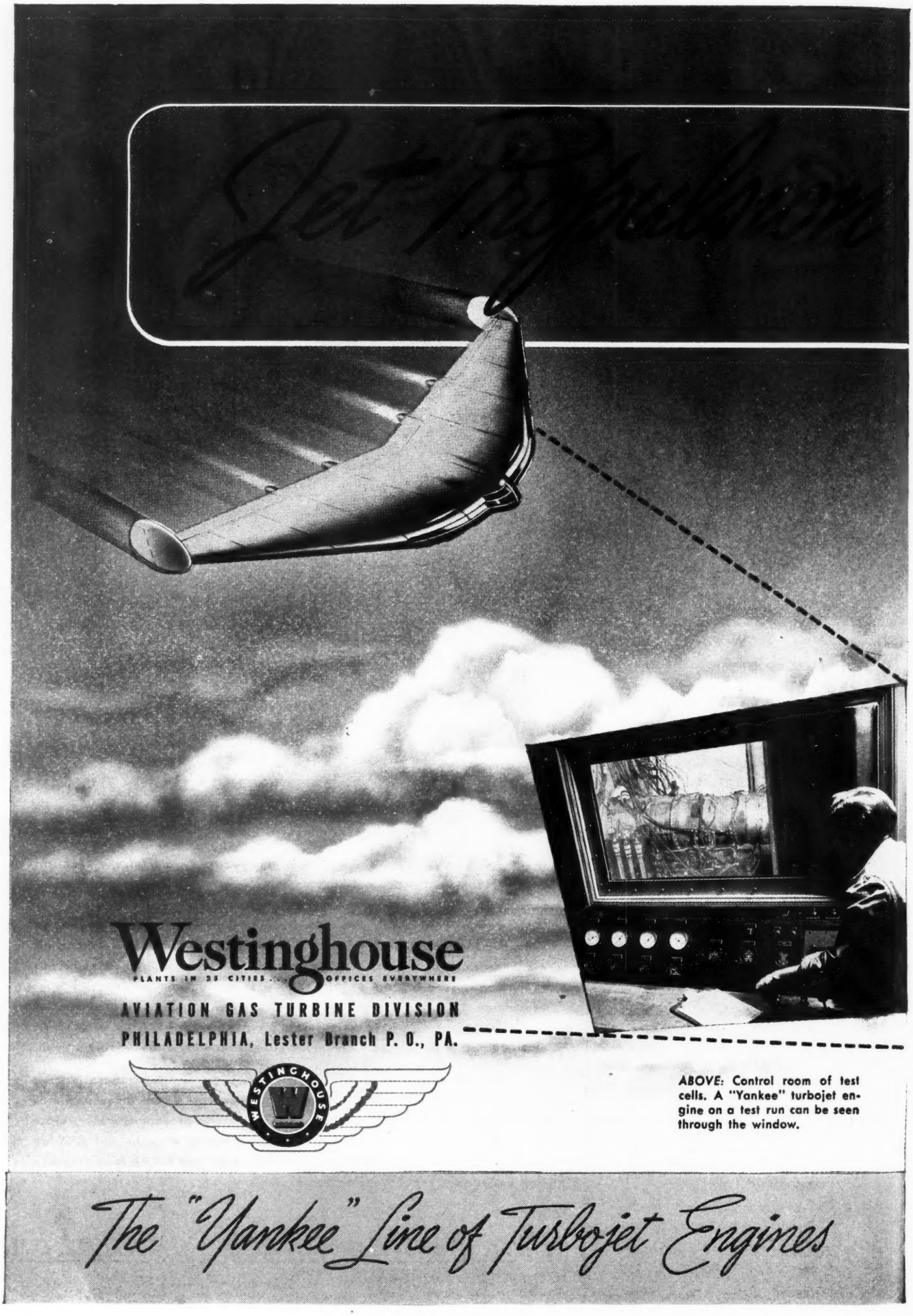
More than 44 years of specialized experience, enriched by intensified research throughout the war, reaches a noteworthy climax in the new R-9A Aircraft Engine which Continental Motors has recently introduced.

The R-9A, and its geared counterpart, the GR-9A, are basically identical with the famous Continental-built radial aircraft type engine which powered some 54,000 medium tanks and Hellcat tank destroyers in World War II. As now offered for aircraft they are special-purpose engines, developed primarily for the planes for feeder line and executive use, now coming off assembly lines in major aircraft plants. In them are embodied numerous refinements, covering the fields not only of design and materials, but of production technique. These advances, proven by millions of hours of operation in aircraft and tanks, result in greater power—525 h.p. in the R-9A and 600 h.p. in the GR-9A—and in increased reliability and economy as well.

In feeder-line applications, where such special performance characteristics as short take-off and fast climb are paramount, and where these surpluses must be gained without compromise on the score of dependability, these new Continental Aircraft Engines are the answer to a great and growing need. A brochure describing the Continental R-9A and GR-9A is in preparation and will be mailed on request.

Continental Motors Corporation

DETROIT AND MUSKEGON, MICHIGAN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Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE
AVIATION GAS TURBINE DIVISION
PHILADELPHIA, Lester Branch P. O., PA.
WESTINGHOUSE
ABOVE: Control room of test cells. A "Yankee" turbojet engine on a test run can be seen through the window.
The "Yankee" Line of Turbojet Engines

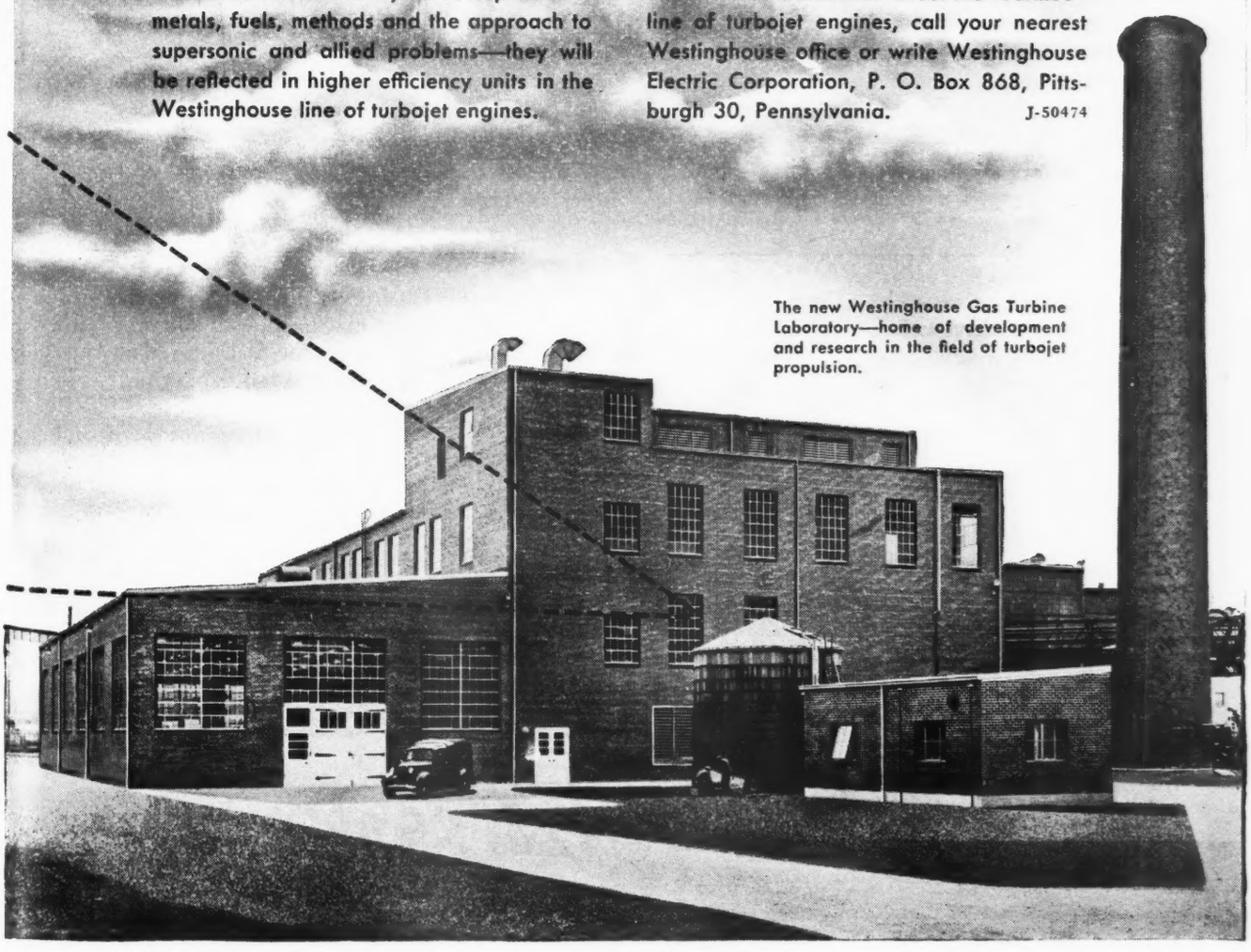
..is put through its paces here...

IN THE NEW WESTINGHOUSE JET ENGINE RESEARCH LABORATORY

This laboratory has been designed by Westinghouse to explore the new frontiers revealed in the development of the first All-American turbojet engine. As new developments unfold within the walls of this three million dollar laboratory—developments in metals, fuels, methods and the approach to supersonic and allied problems—they will be reflected in higher efficiency units in the Westinghouse line of turbojet engines.

Westinghouse research in the field of gas turbine motive power will be continuous and thorough. 52,000 square feet of floor space is devoted to one purpose...bringing turbojet propulsion to its zenith of performance.

For more information about the "Yankee" line of turbojet engines, call your nearest Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50474



The new Westinghouse Gas Turbine Laboratory—home of development and research in the field of turbojet propulsion.

500...COMING UP!

★ **THE BELL MODEL 47B HELICOPTER**—*powered by a six cylinder Franklin Aircooled Engine of 175 H.P.—has a gross weight of 2100 pounds, including a useful load of over 600 pounds. It utilizes a patented two-bladed rotor and gyroscopic stabilizer. The Model 47B is noted for smoothness of flight and ease of control.* ★

FIRST Helicopter in history to be awarded a commercial license, Bell Aircraft's two-place Model 47B is now being put into quantity production. Initial deliveries from the first 500... to government agencies, industry and agriculture... scheduled for early Fall.

This remarkable rotary wing craft offers a new kind of *all-weather* utility. The Bell Helicopter needs no airports, no costly pavements or other landing facilities. It can reach hitherto inaccessible places. And it can land safely in "auto-rotation".

For full facts about the Model 47B Helicopter—performance, operation, utility . . . simply write: Helicopter Division of Bell Aircraft Corporation, Box One, Buffalo 5, New York.

BELL HELICOPTER FIRST IN HISTORY TO RECEIVE COMMERCIAL LICENSE

On March 8, 1946, Bell Aircraft received a CAA Airworthiness Certificate on its two-place Model 47 helicopter, and CAA license number NC 1H, *the first helicopter "NC" license ever issued.* These certificates were issued after exhaustive flight tests in which the Model 47... prototype of the Model 47B... met every airworthiness requirement of the CAA.

THE MODERN MAGIC CARPET*

*Reg. applied for U.S. and principal foreign countries.

BELL *Aircraft* **CORPORATION**

P. O. Box 1, Buffalo 5, New York

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PACEMAKER OF AVIATION PROGRESS

THE GEAR DESIGNER SAID:

"I choose alloys like I chose my wife . . .

because a lifetime is a long time!"

AN odd way to put it perhaps, but the meaning is clear. Any manufacturer who produces machine parts for transportation products knows that he's going to have to "live with" the performance of those parts for the life of the product. When a man buys an automobile or an airplane, he expects the gears and bearings to last as long as the product itself. If they don't, it's a black eye for the manufacturer.

We can help you meet the expectations of your customers and still keep your manufacturing costs in line. Our U·S·S Carilloy specialists make it their business to have at their fingertips the very latest information on the application of alloy steels in the automotive and aviation industries. If you want to reduce weight and at the same time increase resistance to wear, fatigue and shock, our metallurgists can show you how the right alloy steel can be applied to accomplish your objective economically.

U·S·S Carilloy Steels represent your most complete source of high quality alloy steels, now available in all grades, finishes and treatments and in the widest range of forms and sizes found anywhere. A letter from you will bring one of our specialists to your plant, ready to put our metallurgical and production facilities at your disposal.

LISTEN to the United States Steel radio show every Sunday evening. Consult your local newspaper for time and station.

U·S·S Carilloy Steels

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CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
Tennessee Coal, Iron & Railroad Company, Birmingham, *Southern Distributors*
United States Steel Export Company, New York

USS STEEL — UNITED STATES STEEL

UNITED STATES STEEL

THE JOB Stainless steel is difficult to mill under almost any circumstances — but this super-powered CSM, equipped with the proper cutter, literally "walked through" this job.

OPERATION:	Rough Mill Stud	DEPTH OF CUT:	.441" (Max.)
MATERIAL:	Stainless Steel	SURFACE SPEED:	346 SFM
CUTTER:	6" Dia.; 8 Tooth	FEED PER TOOTH:	.020"
TABLE FEED:	21 IPM	MILLING TIME:	26 Seconds

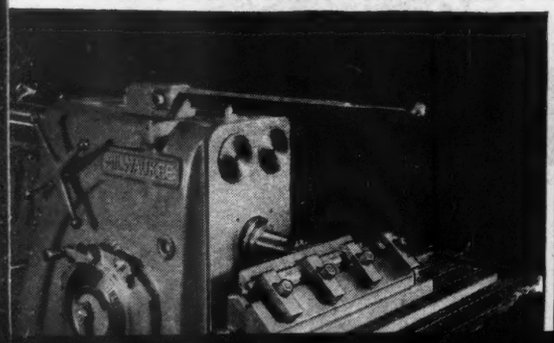
THE PART

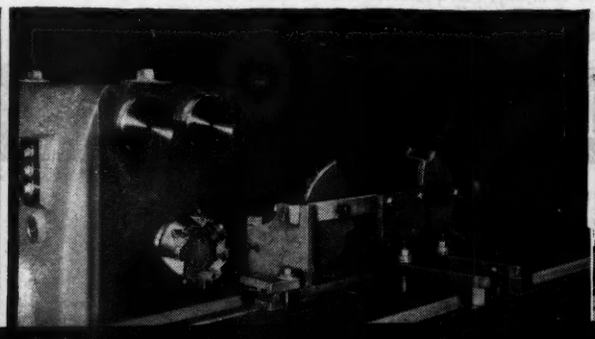
Note the excellent finish obtained despite the high rate of metal removal. The milling time of 26 seconds includes both surfaces. Micrometer stop dial indicator on machine facilitated this step milling operation.

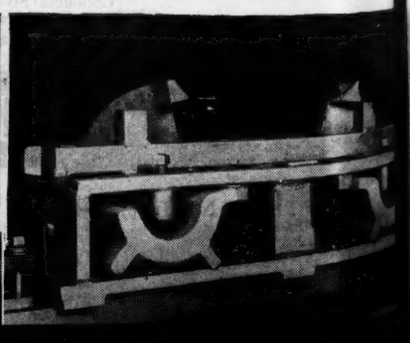
MORE EXAMPLES OF CSM PERFORMANCE

Operation: Rough mill angle on knee gib support—with 34% time reduction. Material: C. I.—Speed: 336 sfm—Cutter: 3" dia., 8 T.—Feed per tooth .010"—Depth of Cut: 5/32". Previous Milling time: 61 seconds — CSM Milling time: 45 seconds.

Two views of set up for milling socket arm part with 65% milling time reduction. Center sh... rear of special holding fixture in place on machine table. At right, machined surfaces of ... Material: Cast Steel—Surface Speed: 346 sfm—Cutter: 6" dia., 8 Tooth—Feed per tooth: .0... —Depth of cut ¼". Previous milling time: 4 min. 52 seconds—CSM milling time: 1 min. 42 ...







STAINLESS STEEL MILLING

made easy on a

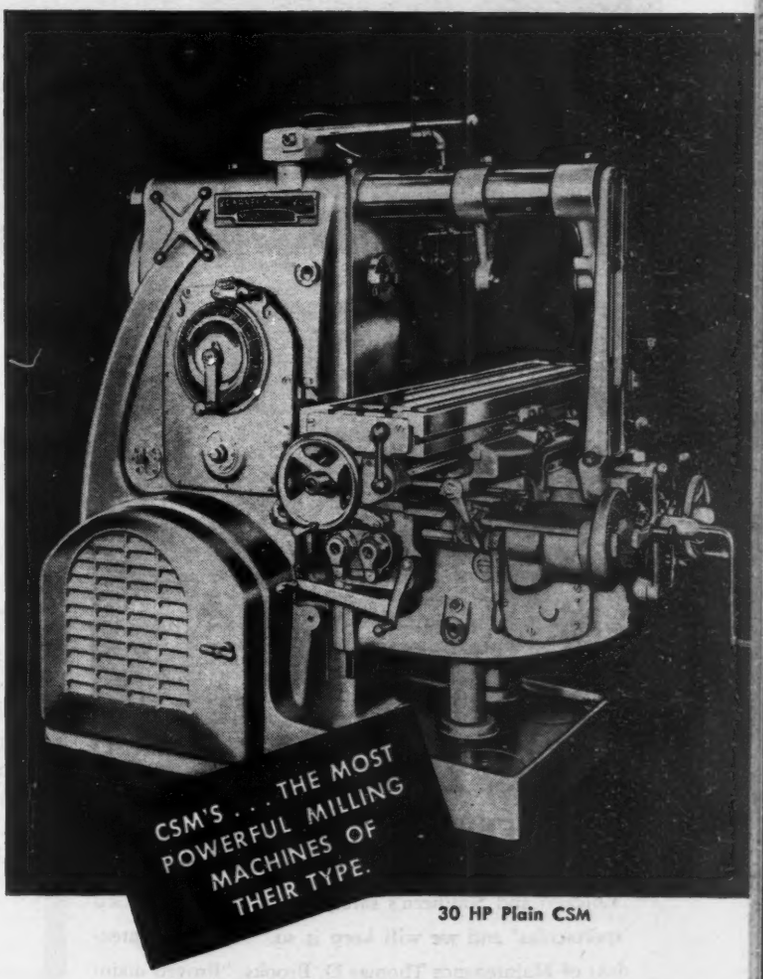
KEARNEY & TRECKER CSM

CSM Milling Machines were designed to obtain the greatest benefits from modern cutting tools, and are now part of our line of standard models. The design has been stabilized after complete analysis of industry's problems of milling with carbide cutters.

Because they are knee type machines, they are readily adaptable to a great variety of work. They are precision built in accordance with long established Kearney & Trecker standards and will cut metals faster and to finer tolerances and superior finishes than ever before — with high speed steel cutters as well as carbide cutters.

CSM machines are available in 20, 30 or 50 H.P. models in both plain and vertical knee types.

Write for complete data on CSM machines — CATALOG CSM-20. Please indicate your business connection.



30 HP Plain CSM

KEARNEY & TRECKER CORPORATION

MILWAUKEE 14, WISCONSIN

"Be ready for tomorrow with CSM's"

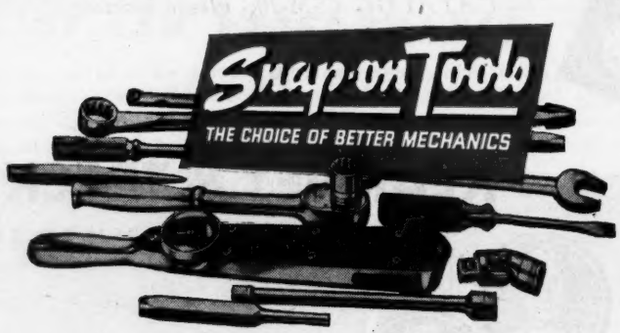
NOW DC-4'S FLY
"The Route of the Dixieliners"

"Sky Steppers" is the name that the army of friendly, hard-working, sure-flying employees of Chicago and Southern are proud to call themselves. Soundly and aggressively this organization has "sky stepped" from modest beginnings to top place as the major Gulf-to-Great Lakes airline. Now a fleet of DC-4's joins the Dixieliners; inaugurating a new era of surpassingly swift and luxurious flight between Chicago and New Orleans, between Detroit and Houston.

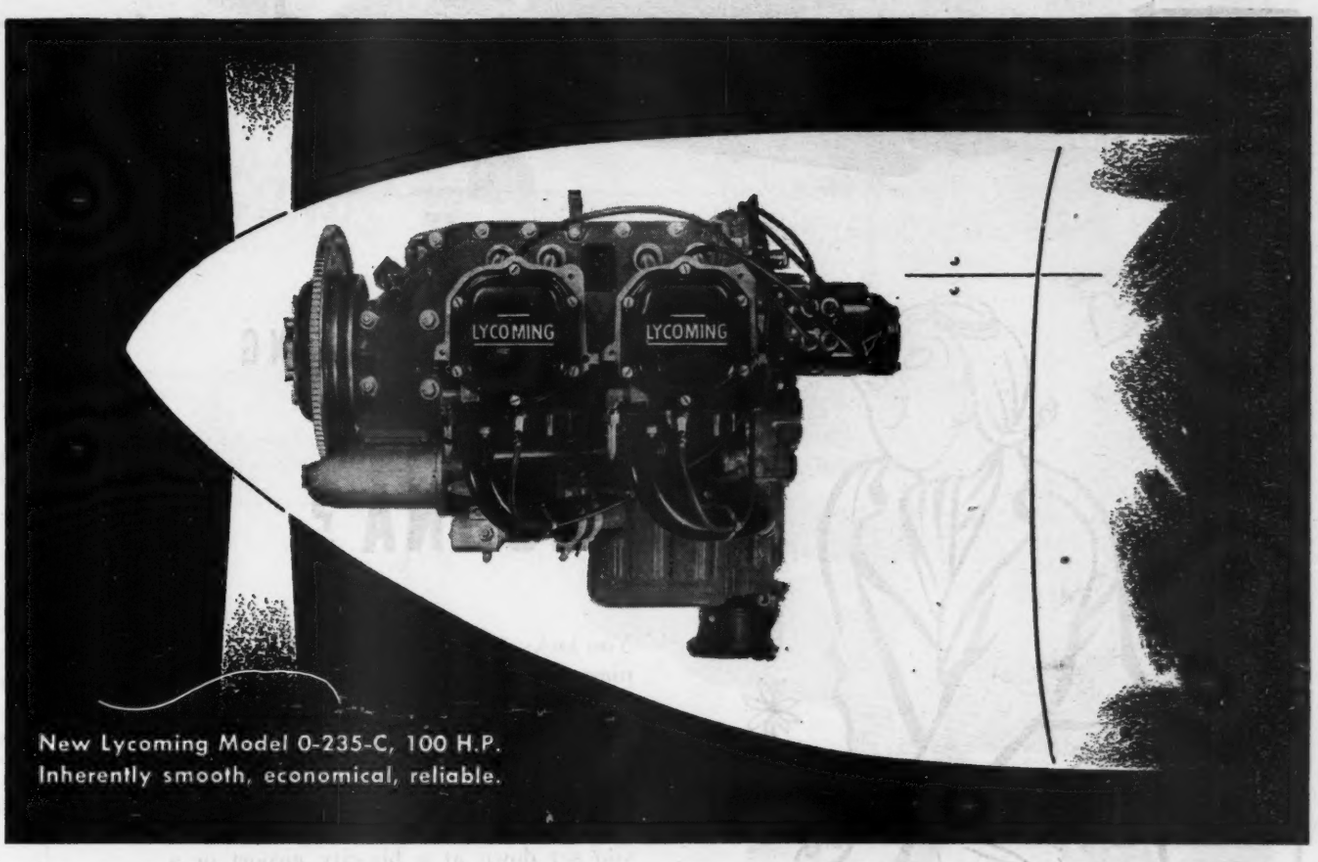
Back of Chicago and Southern's distinguished safety record is conspicuous leadership in engineering developments . . . a leadership which has made many contributions to advanced maintenance practices. Snap-on is proud of the preference which its products have long held with maintenance executives and mecanics of this progressive airline. SNAP-ON TOOLS CORPORATION 8020-F 28th Avenue, Kenosha, Wisconsin.

"OUR MEN PREFER Snap-ons-

"Chicago and Southern's safety record has been called 'spectacular' and we will keep it so," says Superintendent of Maintenance Thomas D. Brooks. "Proved maintenance procedures are ready for our DC-4's and for the big fleet of Martin 2-0-2's to follow. Snap-on tools will continue to play an important part in our maintenance operations. Our men prefer Snap-ons. *It is significant that 75 per cent of the tool boxes in our main overhaul base carry the Snap-on trademark.*"



When you are *UP*—
LYCOMING won't let you *DOWN!*



New Lycoming Model O-235-C, 100 H.P.
Inherently smooth, economical, reliable.

It's a "plane" fact . . . nowhere is reliability more vital than in an aviation engine. Lycoming's engineering experience, plus *years* of flight usage, is your assurance of dependability. Lycoming excels in design characteristics—rugged bearing construction, favorable horsepower-weight ratios, automotive type starter and generator mounted on the *side* of the engine, and other features. But Lycoming design never compromises Lycoming reliability. Reliability alone dictates.

For *safe, sure* flying, insist that your plane is *Powered by Lycoming.*

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AN AVCO PRODUCT **AIRCRAFT ENGINES**

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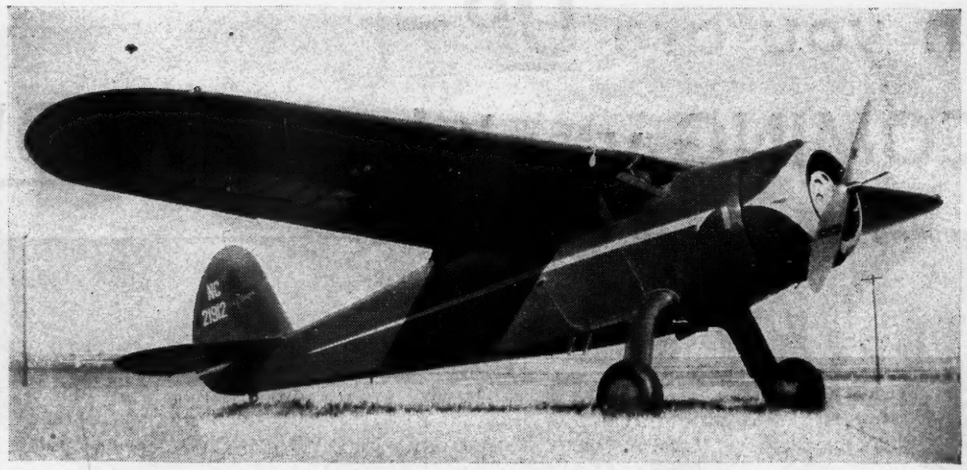
Williamsport, Pennsylvania

Please send me free booklet on Lycoming Engines. I am particularly interested in_____h. p. model.

Name_____ Occupation_____

Address_____



ARE YOU GETTING SWEET ON A CESSNA?

You lucky fellow! It's probably the beginning of a long and beautiful friendship! New places . . . new faces . . . more fun than you've ever had before!

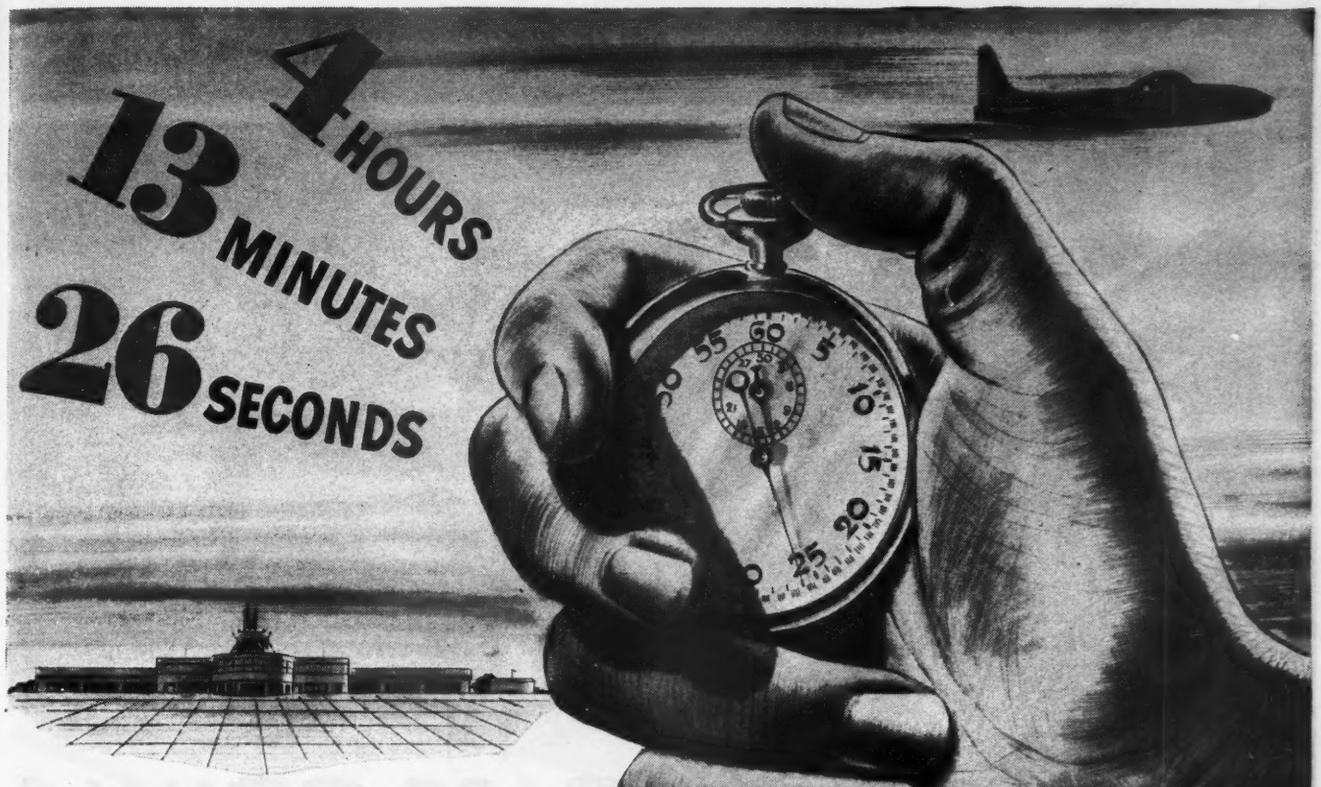
May we make a little suggestion? You'll undoubtedly be flying over Phillips Territory (the great big Middle-West). Whether you set down at a big-city airport or a prairie flying field, ask for Phillips 66 Aviation Products!

They bear the seal of a great company. They were perfected by air-minded men who spend more hours in the air than behind a desk. And, for better carburation and a cleaner motor, we've taken the trouble to manufacture a plentiful supply of *un-leaded* 80 octane gasoline—and to rush it to all the Phillips fields in our territory. Patronize the "66" pump, won't you?

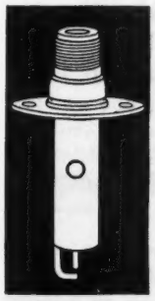
We'll be seeing you!

Phillips 66

AVIATION GASOLINE



A sensational non-stop flight record in which AC engineering had a part



Jet engine plug

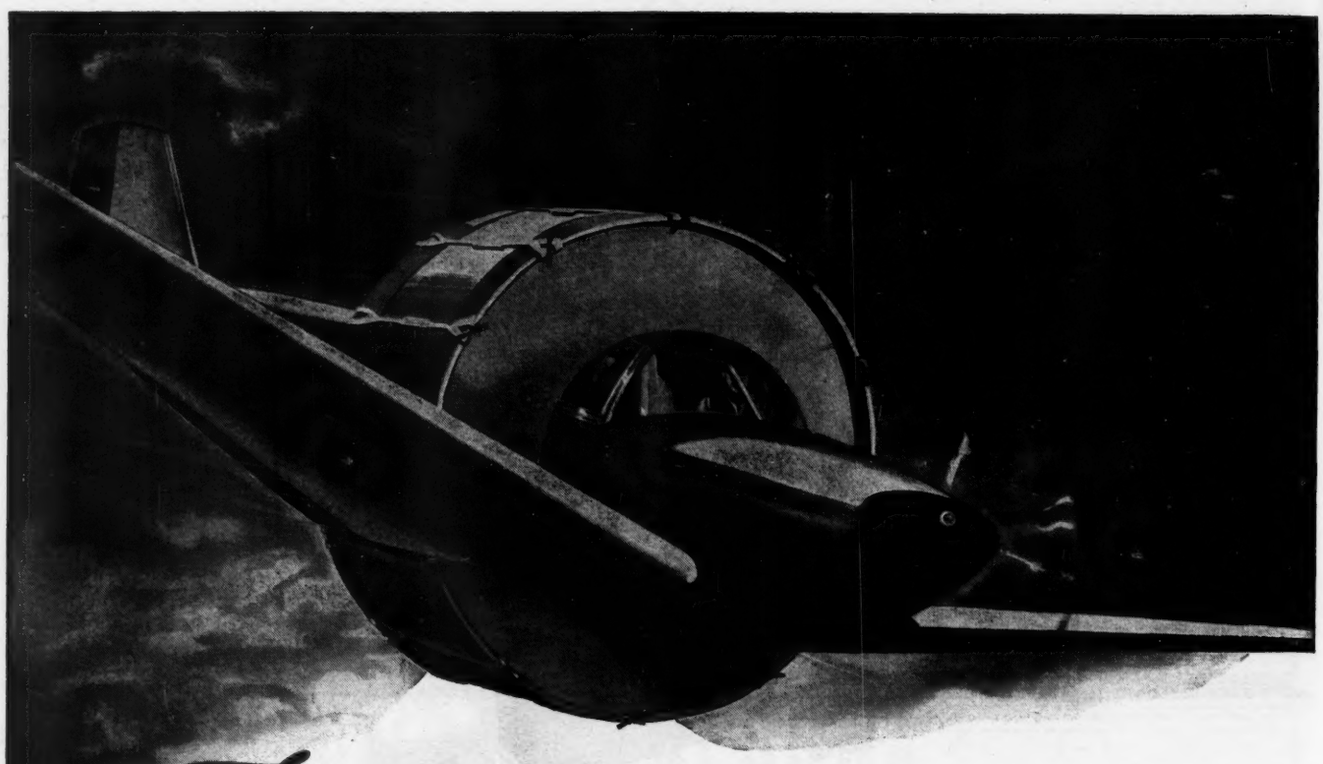
The Army Air Forces, Lockheed, and General Electric worked a great triumph in the cross-country flight of the jet-propelled P-80's which broke all records on January 26 from Long Beach, California, to La Guardia Field, New York. Again America proved its supremacy in the air, and all the world acclaims.

AC jet engine ceramic aircraft spark plugs were furnished, on request, for all three record-breaking P-80's.

Thus, another record is added to the list of outstanding aviation accomplishments in which AC Spark Plugs have shared. From the flights of the "Lone Eagle," Maitland, Byrd, Acosta; to the recent records of The Constellation, the C-97 and these P-80's; the AC name is linked with aviation's multiplying records.

AC SPARK PLUG DIVISION
GENERAL MOTORS CORPORATION

SPARK PLUGS



Flying a big BASS DRUM?

Gone is that "bass drum" pounding—and in its place comes comfortable, quiet flying—when noise levels are effectively and economically reduced with Glidair Sound Deadener.

Manufacturers report that this amazing material saves 50% to 75% of their sound insulating costs—and *reduces weight* at the same time! Plane owners enthusiastically welcome the immediately noticeable decrease in flight noises.

Glidair Sound Deadener is a fibre-filled, resin type material which is applied by trowel or large-nozzle spray gun. Adhesion is excellent—even to *bare metal.* The coating air dries to handle in 4 to 6 hours and dries hard overnight. The non-sticky finish may be covered with dope, lacquer or synthetic enamels without bleeding.

Dealers and operators can obtain Glidair Sound Deadener from their nearest Glidair Distributor listed below. Manufacturers should contact Glidden Aviation Sales Headquarters.

TIME-TESTED

THE GLIDDEN COMPANY

Aviation Sales Headquarters • 11001 Madison Avenue • Cleveland 2, Ohio

GLIDAIR AIRCRAFT PRODUCTS Distributed by

SNYDER AIRCRAFT CORP.....Municipal Airport, Chicago 38, Illinois
SNYDER AIRCRAFT CORP....Sullivant Ave. Airport, Columbus 4, Ohio
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GLIDAIR FLYING COLORS

Made by **Glidden** Pacemaker in Paints

Send for Bulletin No. 55

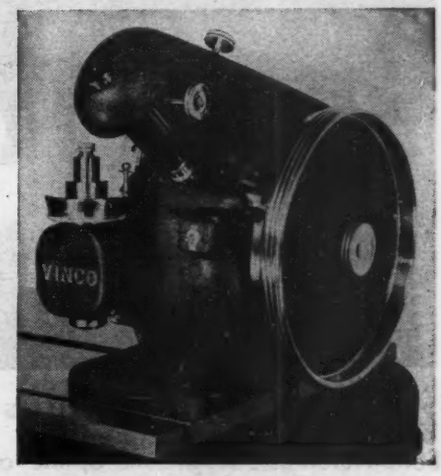
30 Times MORE ACCURATE

What does that mean to you? It means that this proven accuracy is available to you for the inspection of gear teeth, master index plate notches, splines, cams and any other form of angular spacing. It means that final assemblies involving gears, cams, splines, etc., will be subject to less scrappage, because angular spacing errors will have been found and corrected.

Vinco guarantees the OPTICAL MASTER INSPECTION DIVIDING HEAD to be accurate within two seconds of arc; the master disk graduations to be spaced to an accuracy within ONE SECOND of arc; and the ball bearing spindle runout to be within TWENTY-FIVE MILLIONTHS of an inch, total indicator reading (the majority of spindles have less than fifteen millionths runout).

The fact that the VINCO OPTICAL MASTER INSPECTION DIVIDING HEAD has become firmly established throughout industry in such a short time is proof of its dependability and industrial necessity. The following pages cite one of many actual cases where the VINCO OPTICAL MASTER DIVIDING HEAD played a vital role in the production of a toothed part.

Below is the dividing head proper, showing the micrometer, scope, and hand wheel.



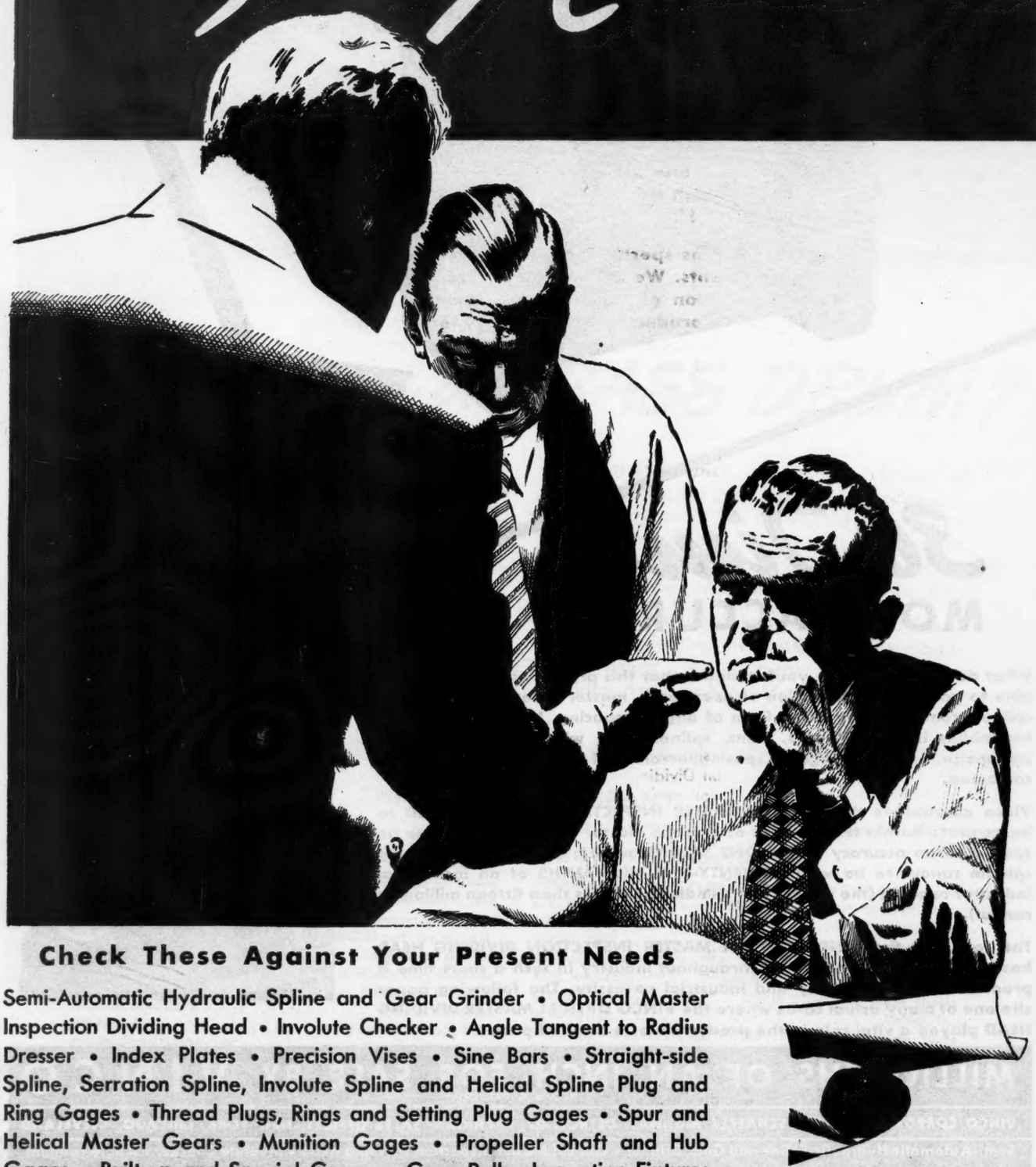
MILLIONTHS OF AN INCH FOR SALE BY VINCO

REG. U. S. PAT. OFF.

VINCO CORPORATION, 8865 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN; SALES OFFICES, NEW YORK, CHICAGO, CLEVELAND

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Shaft and Hub Gages • Built-up and Special Gages • Gear Rolling Inspection Fixtures • Indexing Fixtures • Hydraulic Power Control, Utilization and Distribution Units • Engineering, Design and Development • Precision Production Parts.

They Came to



Check These Against Your Present Needs

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Shaft and Hub Gages • Built-up and Special Gages • Gear Roller Inspection Fixtures • Indexing Fixtures • Hydraulic Power Control, Utilization and Distribution Units • Engineering, Design and Development • Precision Production Parts.

VINCO

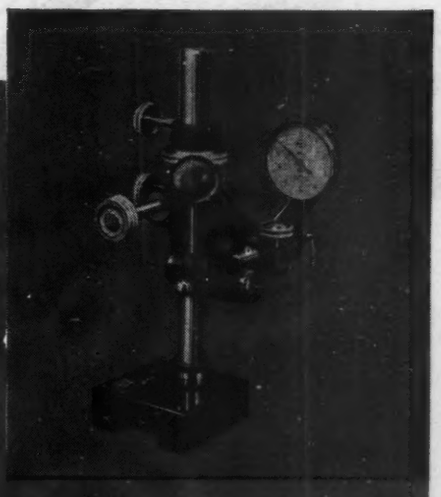
BECAUSE THEY WERE STUMPED BY A REAL "TOUGHY"

It wasn't unusual! This group of production engineers, representing a large eastern manufacturer, had used our precision production service before and were well acquainted with Vinco methods and

Their request was not an ordinary one however! We were asked to produce, in quantity, mating toothed parts with 18 slots, each slot .017″ in width with a tolerance of .0003″ and a root diameter held to a uniformity of .0001″.

These parts were produced exactly as specified and were delivered on time and in quantities over and above specified requirements. We cite this one instance only because it is informative. Our long experience in the production of precision instruments and finely finished gages has given us a decided edge on precision production methods and techniques. Equipment and machines of our own design and make, in the capable hands of highly skilled operators, an engineering force thoroughly grounded in every phase of precision design and construction and a sales organization made up of men who combine a full engineering background with a wide and intimate knowledge of the trends and developments in the industrial field are all valid reasons for a further inquiry regarding this important phase of modern production.

Precision parts by Vinco meet your specifications. Give us the chance to prove it.



The Vinco Standard Indicator Surface

Features of this gage include a .0001″ custom built, full jeweled, dial indicator—differential adjusting screw for final settings—1½″ to 1[illegible]″ work height range—full 360 degree swing of indicator head—readings can be taken on upper or lower surfaces.

Extreme accuracy and flexibility of operation all combine to make this standard indicator gage practically indispensable wherever rapid and close inspection of surfaces is required. (Incidentally, it was used regularly for checking the job mentioned above.) We designed these indicator gages for use with the Vinco Optical Master Inspection Dividing Head, but because of increasing requests they are now offered for general sale.

Vinco Universal Dividing Head

Developed by Vinco to handle light machining or grinding, this universal dividing head played a vital part in the manufacture of the "Toughy". A ratio of 1440 to 1 between handle and work spindle provides an extremely high degree of spacing accuracy, even when using standard commercial dividing head plates.

The dividing head can be mounted either vertically or horizontally. It features a large diameter spindle mounted in a double row of Vinco designed ball bearings, a tapered spindle nose for work adaptors, a face plate of 11″ diameter, a graduated dial on the spindle for initial settings, an auxiliary resetting dial and a 11.459″ pitch diameter helical gear index plate with 360 accurately spaced teeth.

AVAILABLE
NOW

New "IN PLANT GEARING" To Step-Up Production

Remarkable production increases can often be obtained by the application of special gearing to "SPEED-UP" plant output. Here at Western Gear and Pacific Gear & Tool, we have *available now*, a pool of designing talent and engineering skill that goes far beyond the making of gears. We are prepared to apply this talent and skill to your problems of production or product design. The time to call us is when you are planning plant improvements, changes or new products. . . . Call, wire or write our nearest office for immediate engineering counsel.

PACIFIC GEAR & TOOL WORKS ⚙ WESTERN GEAR WORKS

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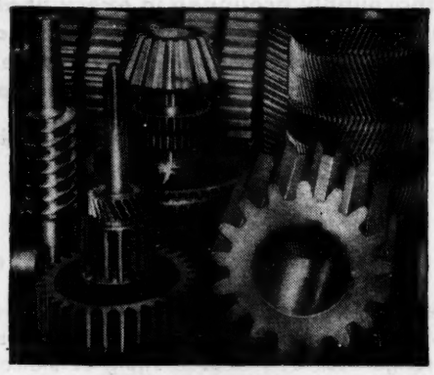
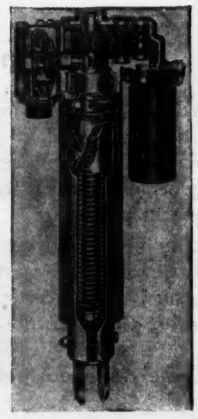
GEARS—for every need



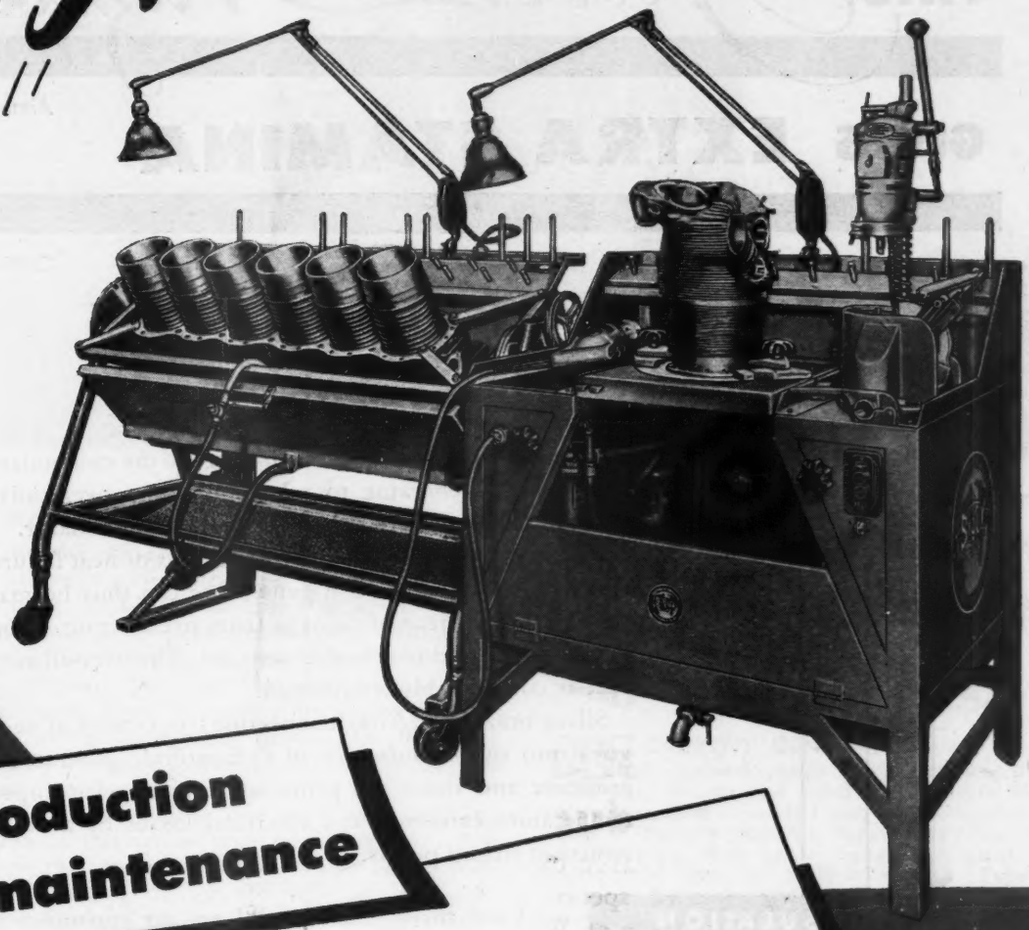
Four conveniently located Pacific-Western plants are equipped to turn out a wide range of gears—continuous tooth herringbone gears, hob cut herringbone gears, helical, spur, spiral, worm, hypoid and zerol bevel gears.

14 lb. ACTUATOR TAKES 16,000 lb. LOAD



B-29 Tail Skid Actuator, designed by Pacific-Western engineers weighs but 14 lbs., yet withstands static load of 16,000 lbs. Unit is powered by a ⅛ hp., 24 volt D.C. reversible motor, has a triple reduction 104:1 gear ratio and maximum operating load of 1,700 lbs. Other Pacific-Western units are now serving in later craft such as Lockheed's "Constellation."

Speed With Precision



in production or maintenance

With

SIOUX AIRCRAFT

wet valve seat GRINDING MACHINE for IN-LINE and RADIAL MOTORS

WRITE FOR DETAILS

STANDARD THE WORLD OVER

ALBERTSON & CO. INC. SIOUX CITY, IOWA, U. S. A.

THIS *Silver-Brazed* BOND GIVES EXTRA STAMINA TO G-E AIRCRAFT GENERATORS

Armature-coil terminal

Commutator riser

An exclusive feature of G-E aircraft generators is the silver-brazed bond that joins the armature windings to the commutator. This feature permits the generator to take short-time overloads which would normally cause failure in a tin-soldered commutator.

In other words, one of the chief causes of heat failure has now been effectively eliminated. G-E generators can thus be made smaller and lighter without fear of damage from overheating. Shop time for generator repair and overhaul is reduced. The over-all service life of each unit is considerably lengthened.

Silver-brazing of vital connections is typical of the *extra* care that goes into the manufacture of G-E aircraft generators. For example, armature and stator are protected against severe operating stresses, temperature extremes, and electrical losses by these additional construction strong points.

GLASS INSULATION

Used throughout to add greater resistance to overheating. An insulated coating on the armature punchings means low core losses. Slots are cushioned with strands of glass fibre.

FORMEX* WINDINGS

Armature and field coils are made with space-saving Formex wire, famed for its resistance to high temperatures, moisture, and corrosion. High-strength building wire firmly binds all windings.

SPARKLESS COMMUTATION

Compensated, interpole shunt-field windings assure sparkless commutation at all loads and speeds within the generator's rating and at high altitudes. Brush maintenance is kept to a minimum.

**Trade-mark reg. U.S. Pat. Off.*

GENERAL ELECTRIC

674-48-8872

Built to withstand hard usage . . .

In addition to the silver-brazed connections shown above, G-E aircraft generators are doubly protected against relentless, racking vibration. A flexible shaft within the armature shaft prevents harmful engine impulses from reaching the armature assembly. It also acts as a flexible coupling between the generator and the engine. This inner shaft is further protected against breakage by a vibration damper drive. The mounting flange is specially designed and fabricated of forged steel to absorb hard punishment.

Aircraft manufacturers and airline operators, realizing that the planes of tomorrow will be judged on their ability to stay in the air and out of the repair hangar, are more and more looking to G.E. for help on their electrical problems. General Electric designs and produces complete aircraft electric power systems in addition to such individual equipment as generator , voltage regulators, motors, cable, etc. Thus, G.E. is in a position to offer wide experience, extensive engineering and testing facilities, and manufacturing "know how." Why not call in a G-E engineer now to discuss your electrical requirements? *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

DIRECT-CURRENT GENERATORS are ideally suited for single-engined planes, and combine high output with light weight and small size. Two- or four-engined planes use them in parallel with voltage regulators to meet heavier load requirements. Type P-2 is rated 200 amperes at 30 volts, with speed ranges of 2200/4500 rpm, 4400/8000 rpm, or 3000/8000 rpm. Type R-1—300 amperes at 30 volts, with speed ranges of 4500/8000 rpm, and 3300/8000 rpm. Type Q-1—400 amperes at 30 volts, with speed range of 4100/8000 rpm.

A-C Constant-Frequency GENERATORS

A-c power systems for larger aircraft are now made possible through the use of G-E 400-cycle, a-c generators, operating at constant frequency. Capacities include 40 kva, 208/120 volt, 6000 rpm; 20 kva, 208/120 volts, 8000 rpm.

A-C Variable-Frequency GENERATORS

G.E. makes a unit rated 200 amperes, 30 volts d-c (10 amperes, 120 volts, single-phase, 800-1600 cycles, a-c) and one rated 10 kva, 0.9 pf, 208/120 volts, three-phase (400-800 cycles, a-c).

Gas-Turbine Starter GENERATORS

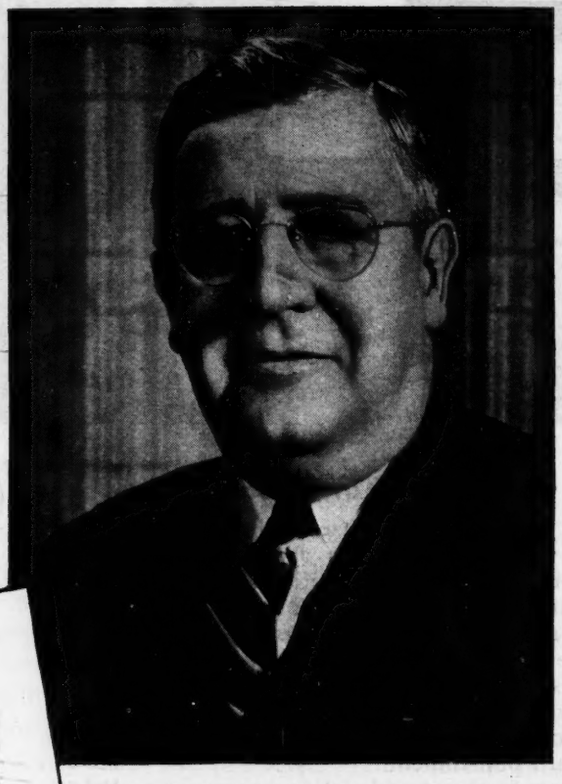
Pioneer in aircraft-turbine design, G.E. also builds starter generators for use with gas turbines. One outstanding type operates on 400-cycle, 30-volt, d-c power over a speed range of 3700/7200 rpm.

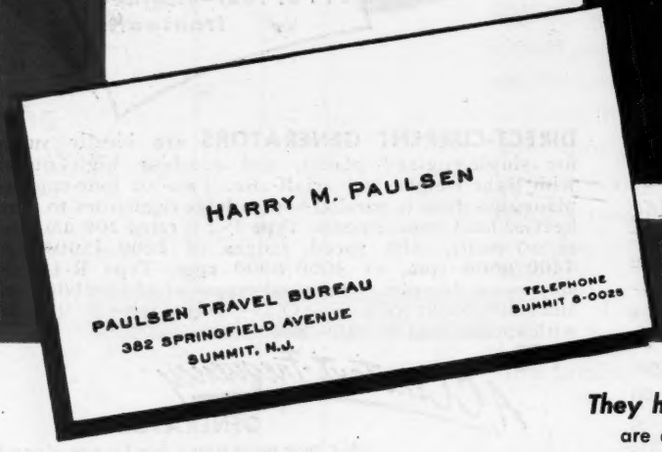
Precision AIRCRAFT GENERATORS

Leading Travel Agents Say: "TIME READERS ARE MY BEST PROSPECTS FOR AIR TRAVEL"

"When I checked over the list of TIME subscribers in Summit, Chatham, Short Hills, and Milburn I was amazed that at least 60% of the names are my best customers now--and practically all of them are on our prospect list. This is again proof that TIME is read by the traveling public, particularly those who travel well and use the airlines frequently."

Says the President of the American Society of Travel Agents, MR. HARRY PAULSEN--Paulsen Travel Bureau, Summit, New Jersey





And straight across the country, leading travel agents agree with A.S.T.A. President Paulsen that TIME readers are their best clients--and the airlines' best, steadiest customers.

They have to be: more than half a million TIME-reading businessmen are executives, department heads, proprietors or partners who fly for the same reason they read TIME—to save time. Almost 400,000 say they regularly take from 1 to 50 airline trips a year . . .

They want to be: a recent survey shows that the 3,000,000 readers of TIME plan to travel *twice as much* as prewar in the U. S. and overseas . . .

And they can afford to be: you reach 1,300,000 families with annual incomes *double* the U. S. family average—when you tell your air-travel story to the air-wise, travel-able readers of TIME.

The Traveler who Reads TIME Flies

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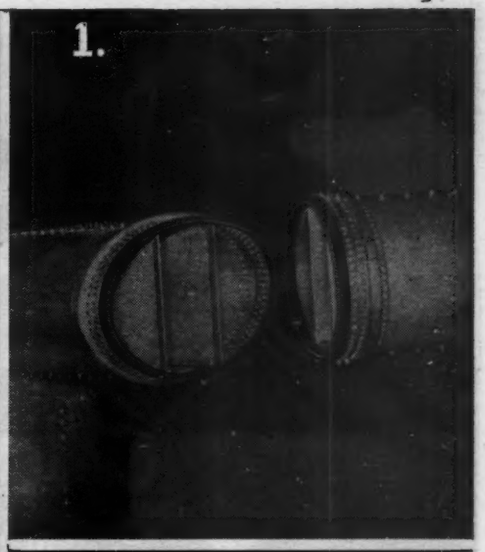
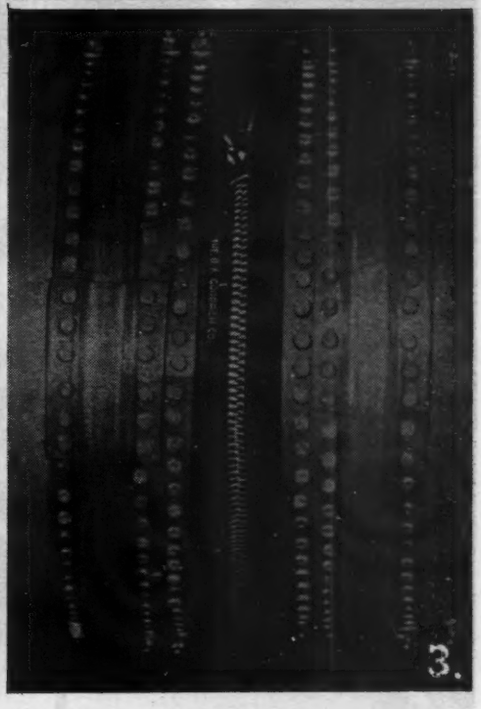




How to zip an airplane's windpipe

TORNADOES of air are sucked in, rammed through, and rocketed out behind four huge propjet engines of the new XF-12, military prototype of the Republic "Rainbow" Transport. All this air roars through long, winding ducts . . . and these "windpipes" used to be problem children.

Ducts had to be made in sections. Sections had to have tight joints because air goes through under heavy pressure. Yet the joints must be easily disconnected and re-sealed to permit frequent removal and replacement of duct sections. And that was a puzzler.

A new type of B. F. Goodrich Zipper supplied the answer. Not the ordinary kind, but one that's made with a precision-molded rubber seal that opens and closes with the zipper. A unique arrangement of overlapping rubber lips provides an effective seal for pressures up to the structural strength of the zipper itself.

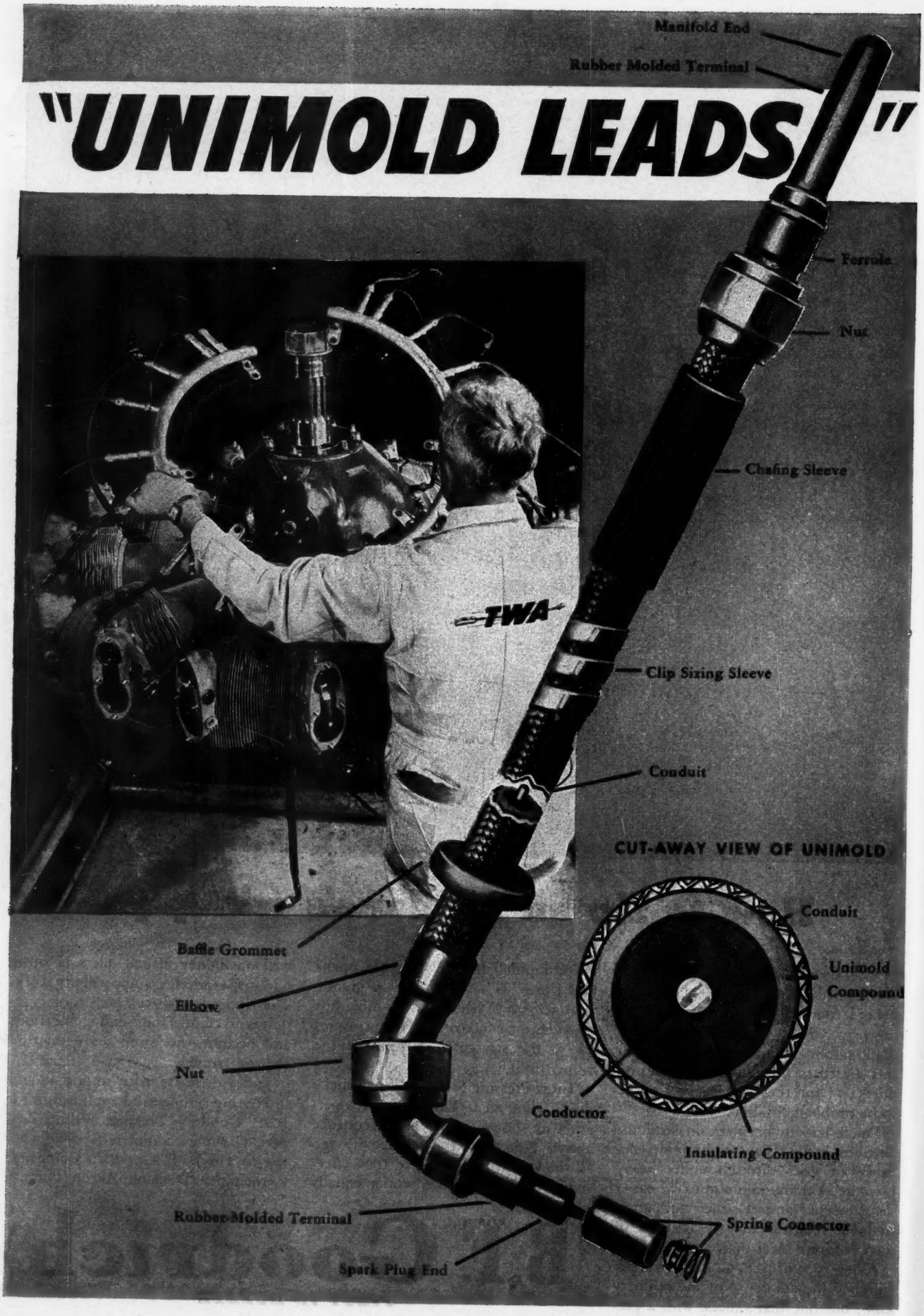
These Pressure-Sealing Zippers make duct sealing an amazingly simple operation as shown in the 1-2-3 sequence above. Note that the molded lips go all the way around, to give 100% effective seal. This feature works equally well on kidney-shaped ducts or other odd shapes where clamps will not work. The zipper is a space-saver, too. It requires no cumbersome end connections and occupies no more space than an ordinary zipper.

Today there are many important and interesting aeronautical applications for B. F. Goodrich Pressure Sealing Zippers. Get more complete facts by writing to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

B.F. Goodrich

FIRST IN RUBBER

"UNIMOLD LEADS"



Increased Ignition Service Life
New Operating Economies

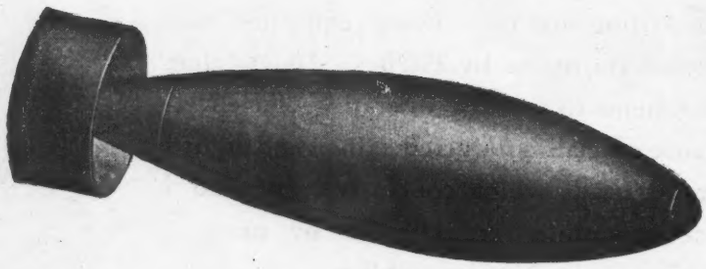
All Wright-powered DC-3's and Stratoliners of TWA-Trans World Airline are now being equipped with Unimold Ignition Harnesses by Titeflex. *Always* alert for new developments to increase operating efficiency, TWA maintenance officials conducted exhaustive flight tests with Unimold Leads which conclusively proved that maintenance economies are effected by using Unimold detachable lead ignition assemblies.

In TWA flight tests *not one electrical failure* developed in any of the ten lead *sets* tested. When all planes are Unimold equipped a large decrease in flight delays previously caused by ignition difficulties is anticipated.

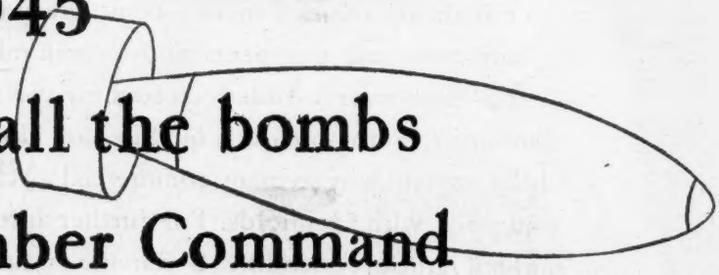
In Unimold ignition leads the conductor and end terminals are molded in one complete unit—preventing moisture and gas penetration—minimizing "corona" and "flash-over". Added to economy and service life—superior radio shielding qualities of Unimold assemblies explain why so many commercial aircraft are being equipped with Unimolds. For further information on molded ignition assemblies by Titeflex, write us on your company stationery.

Titeflex

Titeflex, Inc., 510 Frelinghuysen Avenue, Newark 5, New Jersey



from 1942 to 1945
two-thirds of all the bombs
dropped by Bomber Command
were dropped by



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SUPERPLANES BY AVRO

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Specify C-D MICABOND

The power that drives a Diesel Locomotive is Electricity! Electricity generated by huge Diesel Driven Generators . . . generators that depend on C-D MICABOND insulation to stand the high heat and vibration of continuous operation. The small armature illustrated separately is used in your automobile generator . . . it too must give long-dependable service . . . furthermore it must also be economical to produce so it is built on a fast moving assembly line. Accuracy in dimensions is essential in both these uses of C-D MICABOND insulating rings and segments . . . first to insure unfailing service; secondly to facilitate fast economical assembly.

C-D MICABOND is Mica in usable forms. MICA splittings bonded together in sheets and tubes from which segments, rings and other shapes are readily and accurately fabricated. Into every shipment of C-D MICABOND goes a half century of C-D "know-how" . . . your assurance that C-D MICABOND is engineered to do the job for which it is specified.

C-D PRODUCTS

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DILECTO—Thermosetting Laminates.

CELORON—A Molded Phenolic.

DILECTENE—A Pure Resin Plastic Especially Suited to U-H-F Insulation.

HAVEG—Plastic Chemical Equipment, Pipe, Valves and Fittings.

The NON-Metallics

DIAMOND Vulcanized FIBRE

VULCOID—Resin Impregnated Vulcanized Fibre.

MICABOND—Built-Up Mica Electrical Insulation.

Standard and Special Forms

Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

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Engineered Dielectrics

KWC-46

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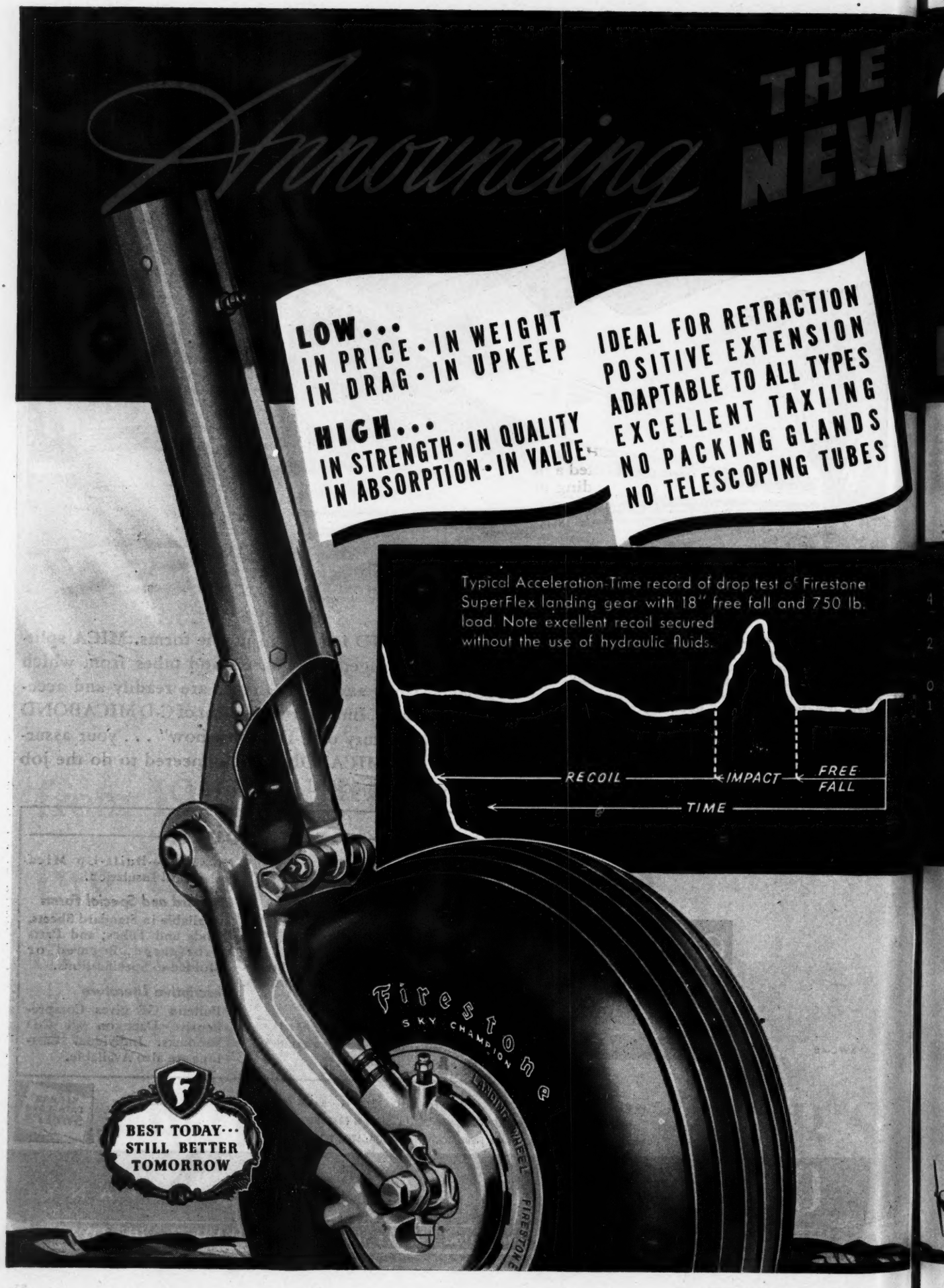
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LOW...
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IN DRAG • IN UPKEEP
HIGH...
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IDEAL FOR RETRACTION
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EXCELLENT TAXIING
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Typical Acceleration-Time record of drop test of Firestone SuperFlex landing gear with 18" free fall and 750 lb. load. Note excellent recoil secured without the use of hydraulic fluids.
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BEST TODAY··· STILL BETTER TOMORROW

Firestone

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The Firestone SuperFlex landing gears were especially designed for personal aircraft with maximum gross weights within 3,000 pounds.

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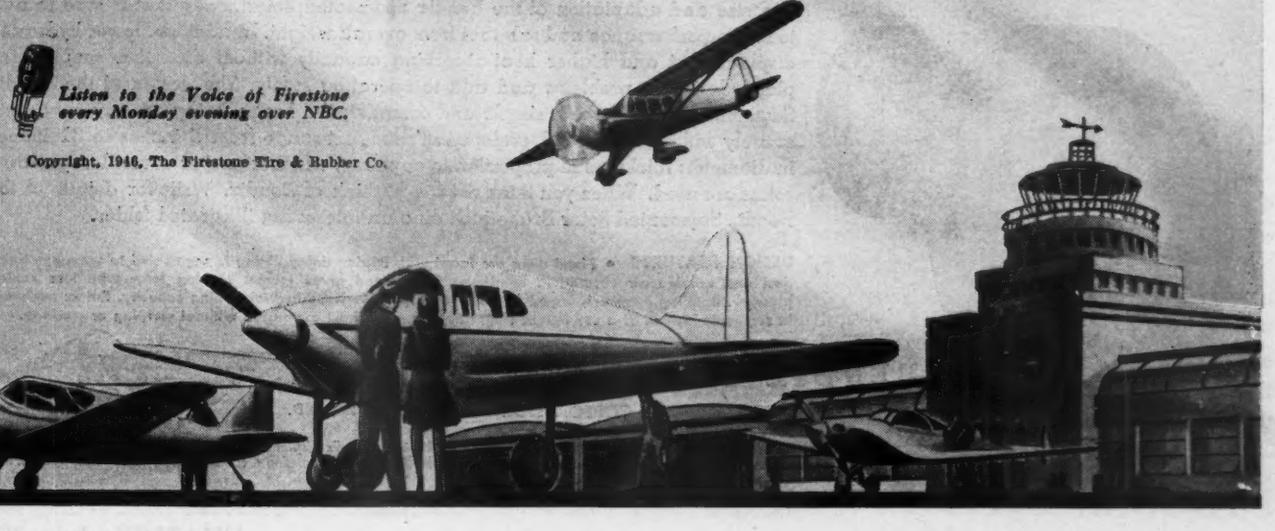

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Congress has acted—and along these lines—since this editorial was written. If the President signs the legislation, we have taken one step forward. If he vetoes it, the voters must resolve a conflict between two branches of their government.

THE LABOR CRISIS
—*it's up to Congress*

IT HAS remained for John L. Lewis to demonstrate conclusively that, under the sponsorship of the federal government, the power of organized labor has been built up to a point where it can be used to paralyze the economic life of the nation. Therefore, in the elemental interest of self-preservation, the first order of the day is to cut down the power of organized labor to a point where irresponsible leaders no longer have the power to use it to cut down the country.

This will prove an exceedingly complicated job. The federal government, over a dozen years, has developed and buttressed the power of organized labor by many separate steps. They are interlaced in a pattern which cannot easily be unravelled.

Cutting down the power of organized labor to proper proportions will be an operation almost as delicate as brain surgery. To be successful it must impair no basic American political or economic right. It must leave intact the right of workers to organize and bargain collectively through representatives of their own choosing. It must leave intact the right to strike. But it must disassociate from the exercise of these rights opportunities for devastating abuse of the public welfare such as those demonstrated by Mr. Lewis. A meat axe is not the instrument for this operation.

Because of the complexity and delicacy of the operation to be performed it would be helpful if it could be carried out in a tranquil atmosphere. The urgency of the problem is such, however, that no time can be lost in getting at it.

Guiding Principles

However, the dangers that haste or heat will lead to serious blunders can be largely eliminated if the process of bringing the power of organized labor back within safe and reasonable bounds is governed by principles to which all fair minded people can fully subscribe.

The most important of these principles is that it is an abuse of public authority to extend special privileges to organized labor.

When in 1935 Congress passed the Wagner Labor Relations Act, one of the great buttresses of the power of organized labor, it was upon the explicit theory that organized labor was weak and needed coddling by the federal government if it were to survive, let alone grow big and strong. In the policy section of that act it was stated that "the inequality of bargaining power between employees who do not possess full freedom of association or actual liberty of contract, and employers who are organized in the corporate or other forms of ownership association substantially burdens and affects the flow of commerce . . . "

Regardless of whether or not that was a correct reflection of the situation in 1935, it bears no relation to the situation today. Under the continuous sponsorship of the federal government, the power and bulk of organized labor has waxed until today it is preposterous to regard it as the weak sister in its bargaining with employers. If, after being continuously demonstrated since V-J Day, the proposition that the pendulum of organized power has swung too far over on the side of organized labor needed any final and clinching demonstration, John L. Lewis provided it.

Changes in the Law

Translation of the principle that organized labor is no longer a weakling, requiring a diet of special privileges, into specific legislative enactments is a detailed technical operation beyond the scope of this statement. It is possible, however, to indicate some of the general lines it should follow. Here they are:

1. The duty to bargain collectively, now imposed upon employers by the Wagner Act, should also be imposed upon the leaders of organized labor who are now under no legal compulsion to bargain.

   For well over a month Mr. Lewis made a complete mockery of the process of collective bargaining by refusing even to state his demands until the coal operators had approved "in principle" a plan for a miners' "health and welfare" fund which he fancied. In the meantime the country was plunged into an ever deepening crisis.

2. Unions, as well as employers, should be made liable to suit for damages for breaking their collective bargaining agreements.

   A degree of responsibility commensurate with their age and power requires that unions be liable, to the extent of union funds but not the funds of individual members, for carrying out their agreements. To have it otherwise is to hold that a collective bargaining agreement is, by defi-

nition," a phoney agreement so far as the union is concerned. Outlaw strikes are the fruit of this lop-sided arrangement.

3. Employers should be given more discretion, in reinstating employees who have gone on strike than is now permitted by the Wagner Act.

The Wagner Act largely eliminates the risks involved in striking because of the requirements it imposes upon employers to take workers back when they have decided to return to work. These requirements make it virtually impossible for the employer to replace workers even if they are engaged in the most unjustifiable of strikes. At the least workers who have smashed up property and stirred up violence in the course of a strike should have no rights under the Wagner Act. How much further the Wagner Act straitjacket should be loosened at this point should be carefully explored, and excesses encouraged by the Act should be removed.

4. The wedge which the National Labor Relations Board has driven into the orderly conduct of American industry by holding that foremen are covered by the Wagner Act should be eliminated.

The issue involved here is continuously mislabelled and confused as that of the right of foremen to organize. There is no question of the right of foremen to organize any kind of a legal organization they desire. That is their right as American citizens. The issue is whether or not the special privileges accorded by the Wagner Act, which in some circumstances has been so construed as even to prevent employers from talking with their workers, should be extended to foremen who, if American industry is to have a chance to do its duty effectively, must represent management with full loyalty and responsibility.

A member of John L. Lewis' United Mine Workers takes an oath which provides, in part, "that I will not reveal to any employer or boss the name of anyone a member of our union" and will "defend on all occasions and to the extent of my ability the members of our organization." Mr. Lewis insists that the coal operators contract to deal with foremen to be organized in a union where they will take that oath, and where their activities will be separated from the influence of employers by the barriers imposed by the Wagner Act. Such an arrangement undercuts orderly management of American industry.

5. The exemption of labor unions from the federal anti-trust laws, provided when organized labor was presumed to be weak, should be modified to take account of its vastly increased strength, and the use of this strength to destroy business enterprise and create monopoly.

As matters stand unions can run employers completely out of business by secondary boycotts and run fellow workers out of jobs in the process. An Ohio manufacturer, working with a government-certified C. I. O. union, is put out of business because A. F. of L. workers refuse to handle his products. Still the government, this time in the person of the United States Supreme Court, says that actions of this sort are above the law because Congress exempted unions from the federal anti-trust laws.

To eliminate one of the most devastating forms of restraint of trade, this exemption should be cut down forthwith by subjecting unions imposing secondary boycotts to the same penalties under the federal anti-trust laws as those to which employers doing the same thing are subjected. And the question of further narrowing the obsolete exemption of unions from the federal anti-trust laws should be fully explored.

6. The levying of special sales taxes for the exclusive benefit of unions should be prohibited by law.

As a matter of good government the right to levy consumption taxes should be reserved to the public authorities and used strictly for public purposes. As a matter of good economics, payments to workers or their organizations should be included in the payroll where they can be properly counted as part of the cost of production.

Equality Before the Law

When everything that can conceivably be accomplished by legislation has been accomplished there is no reason to believe that an ideal or even a surely workable system of industrial relations will have been devised. Many of the mainsprings of such a system lie deep in the hearts of men and far beyond the reach of legislation. There is no chance, however, of having such a system, or even a defensible system of democratic government until special privileges which tip the scales of power far on the side of organized labor are withdrawn and there is some measure of equality for employers and organized labor before the law. Though it is hard to believe it at the moment the country may come to be grateful to John L. Lewis for driving that lesson home so ruthlessly.

President, McGraw-Hill Publishing Company, Inc.

EDITORIAL

Here's an "Or Else" For the Lightplane Business

DURING 1946 about 20,000 Americans will buy personal planes. Many of them will become pilots—a new experience. A certain percentage will be disappointed in flying; their craft will be offered for sale, and probably resold later. Yet, there will be many thousands whose orders cannot be filled until next year. And 1947 should be even better, unless economic conditions prevent. The new Federal Airport legislation will contribute to the personal flying activity. But where do we go from there?

It is all well and good for the manufacturers, salesmen, fixed base operators, and others who will profit, to rub their hands vigorously and think, "This is the boom we have been waiting for." And it is. But one may ask, "Just what are you fellows doing to keep this business going after the first buying wave has receded?" Here are a few thoughts in that direction:

Manufacturers must not shirk industrial management's traditional responsibility—to give the consumer even more for his dollar. This is the fundamental secret of success in any business. And airplane making is no different from anything else. This responsibility is vested not only in the builder of aircraft. Every maker of parts or equipment must share it.

In our May issue we told the story of a manufacturer who left no stone unturned to reduce his costs. He went back to basic engineering and simplified design, and there he accomplished part of his aim. He bought an engine company of his own, and that helped some more. He whittled down prices relentlessly for every part and piece of material that went into that airplane. And he is still doing it. Then, too, he opened his shop to his competitors and told them freely what he was doing.

Maybe you don't agree with this man but it might be wise to follow his example, because the customers like his product and his price—and that's all that counts.

ONE ACCESSORY MANUFACTURER who couldn't meet this project's price competition reported he was happy about losing the business. He said it was a good test for him and that he was going back to research in order to design a product that would undersell his competitors. This is the spirit which has made American industry great. It is highly encouraging to find it in the aviation business.

Aviation has become a real business. The days of fat markup for commercial products, because they are stamped "aviation," are numbered. Someone is going to get cost down for aviation products. And it would be far better for the experienced old timers to do the job than for newcomers to take the business away from them.

In recent weeks, reports from new plane owners indicate that some manufacturers are exaggerating weight allowances for their craft. This practice, reminiscent of the late '20s constitutes the worst possible business practice. It is true that many well-designed aircraft will safely carry more than their certified load, but it is inexcusable for manufacturers to allow their planes to be sold on such a basis, even if an increased allowance is confidently expected. Nothing could do the industry more harm. It is the responsibility of the individual manufacturer and the Personal Aircraft Council to check this practice before it becomes widespread.

THE AIRCRAFT DISTRIBUTOR and the airport operator also have a broader responsibility to the customer than is generally realized. Like manufacturers, their most important job is to work relentlessly to cut the cost of airplane ownership. Hangar rental is the big fixed item of expense for the owner. The large hangar with its high, elaborate roof structure is an excellent place for maintenance work but uneconomical for aircraft storage. In spite of present high building cost, individual hangars can be constructed at prices low enough to provide reduced rental, and on a reasonable basis of amortization. It is a good idea to build a few blocks of them now, maintain a reasonable rental in keeping with the present demand, and be prepared to reduce these rates later when demand levels off. There are many other ways in which increased operating efficiency can be passed on to the customer, and reduced flying cost will enable more people to own planes.

Another frequently unrecognized responsibility of the operator is to help make flying more interesting. All past experience shows that interest in plane ownership begins to lag after a season or so of hopping in and out of the home airport. Cross-country flying must be encouraged and stimulated, and this can be done with little effort on the part of the operator. Seek out some gregarious customer with sufficient leisure to organize tours and breakfast flights, and show him how to have this fun. Others will follow, and thus new interest in flying is developed.

These are but a few of the things that can be done to keep this business going. Many ideas will present themselves to the alert and imaginative operator. When airplanes are made economical and useful objects of recreational desires, personal flying will come into its own and the future of this fascinating field will be assured.

Leslie E. Neville

EDITOR

"CROSSROADS" CRITIQUE

By **HERB POWELL,** *Associate Editor, "Aviation"*

Examining both accepted and disputed fundamentals behind the imminent Atom Blast Four, this preview relates the whys and hows of the comprehensive test at Bikini—where aviation's leading role will be accented.

FOR GREATEST CLARITY in our conception of Bikini, it's best that we first carefully examine the record of the A-bomb to date—to obviate the many confusions which are hazing its status.

To run our finger down the fundamentals, let us specifically note that fast nuclear fission, and the apprehensive age it ushered in, is not even a year old. Yet, in this relatively short time, myriad problems have been posed and then pounded under an unparalleled flood of public concern, with minds the world over attempting to grasp the new significances. Heavy pressure of this attention is fogging the facts.

Fundamental No. 1 is that we still know next to nothing about the A-bomb's key characteristics, and it certainly behooves us to go about the business of noting and gaging them. There are those who would ban such tests as Operation Crossroads. But contrary to their contentions, full knowledge gained can actually aid us in following the humanitarian, rather than militaristic, path into the future. From now on, we will have to carry this Pandoratomic Box with us, and we'd better know precisely what's inside it. Lack of such knowledge can only lead to false security. The ostrich has taught us that there is no sense in the premise that "what you don't know won't hurt you."

It could hardly be expected that comprehensive information could be gathered in the course of the three previous A-bomb detonations. At Almagordo, in July 1945, there was not an iota of past experience for the scientists to go on. They were understandably chary in this initial approach. Moreover, neither theories nor apparatus of investigation had then been brought to satisfactory development.

With Hiroshima and Nagasaki, in

Controlled from panel (left foreground), Navy Hellcat drone streaks to robot takeoff from deck of carrier Shangri-La. Such pilotless craft will weave through blast cloud to bag atomized air and get instrument recordings, then be "mothered" to landings for scientific investigations. Should strong radioactivity kill ignition systems and crash drones, such rays may be seen as new weapon. (Press Assn. photo)

August, there did come additional understanding. Granted. But these blasts were under war conditions; requisite studies could not be mounted in the direct face of the enemy.

Accordingly, the fourth blast—slated at Bikini Atoll next month—stands as the first opportunity in which essential implementation, instrumentation, personnel, and timing are being arrayed to determine data sought. So, on our first fundamental, Bikini makes sense.

Fundamental No. 2 is that A-bomb operations are distinctly of the air, not of the land or of the sea, even though experimental variations may be tried (such as the plan for detonating Blast Five from a barge, in order to assure explosion at or just below water level). We find aircraft the key to A-bomb carriage today, with the Boeing B-29 exemplifying the type of plane currently affording the capacity to handle these new destroyers. Hence, the basic role of aviation in the A-bomb scheme is evident.

It would be begging the question to try to discount aviation at this point by theorizing that warships might have pumped these blasters into Japan with special guns. This would imply the use of a much-too-slow assault medium. Speed must go with speed. Besides, it is a fair assumption that various mechanics of such a non-plane attack would be faulty.

Tomorrow, true enough, special projectiles hurtling far above the earth at supersonic speeds are visualized doing the carrying job. Yet even these missiles may well come under the aviation definition, specifically so if they require some kind of wing (fing) design.

In any event, however, we should steer clear of the over-the-boundary type of future-thinking. There's an analogy in the unrealistic attempt to tie the "obsolete" tag on the aircraft carrier. This kind of erroneous ranging might lead us astray with our aircraft-A-bomb team, a combine which we may logically figure will continue.

Turning now to specific considerations of joint Army-Navy Task Force 1's fourth blast at Bikini, we find the target involving more than 70 surface vessels disposed in concentric fashion, with the Battleship *Nevada* at the hub. Next out from this aiming point will be ranged other major ships (battleships, cruisers, and carriers), such as the *Nagato, Pensacola, Independence, Sakawa, Arkansas, New York,* and *Salt Lake City.* Somewhat farther out come the *Pennsylvania, Saratoga,* and *Prince Eugen.* Then "filling in" at varying distances will be destroyers, submarines, attack transports, landing craft, a floating drydock, and a barge. The pattern has been carefully planned to test effects in ratio to distance. Features of a typical anchorage, also of a task force at sea have been integrated in the layout.

Carrying out the many different air missions will be some four score directly involved aircraft, along with a miscellany of others. Their types and operations will be detailed in later paragraphs. The bomb itself (stated to be the same type as that used at Nagasaki) is to be detonated in the air over the target fleet. In a later test (perhaps in August) a fifth blast is projected at the surface of the water. There are also plans—at this writing seemingly only tentative—for an underwater blast test in 1947.

At this point, we may call it Fundamental No. 3 to evaluate all controversial angles. For one thing, the matter of the underwater blast has stirred up considerable contention on the part of scientists, who appear agreed that it is this test which promises to send the most destructive forces against naval vessels, because of the fact that, as compared to the air medium, the water medium will translate greater compression farther. Convinced that a strikingly higher violence would be set up by this underwater bomb, the savants see little relative significance in the fourth blast, and not much more in the fifth. They raise a sharp question at the seeming lack of definite plans for what they term the really meaningful sixth blast.

A very harmful public reaction is feared—because the strongly built, water-cushioned vessels may well resist the forces of the fourth and fifth detonations. Foreseen are heavy headlines reading, "A-Bomb Fails To Destroy Fleet"—leading the man-in-the-street to an extremely erroneous, "See, it isn't what it's cracked up to be." Test leaders themselves bear out this unfortunate possibility, admitting that results will not be "so overwhelming or so unexpected" as to solve prime questions of future Navy or Air Force needs, of obsolescence of surface ships, or of new tactics and strategies of bombing.

This opens up two further questions: Since an A-bomb-heeled enemy would be expected to strike directly at our major cities, rather than at our fleet, why not test the bomb against a city with occidental buildings "and really find out what we may be in for." Here,

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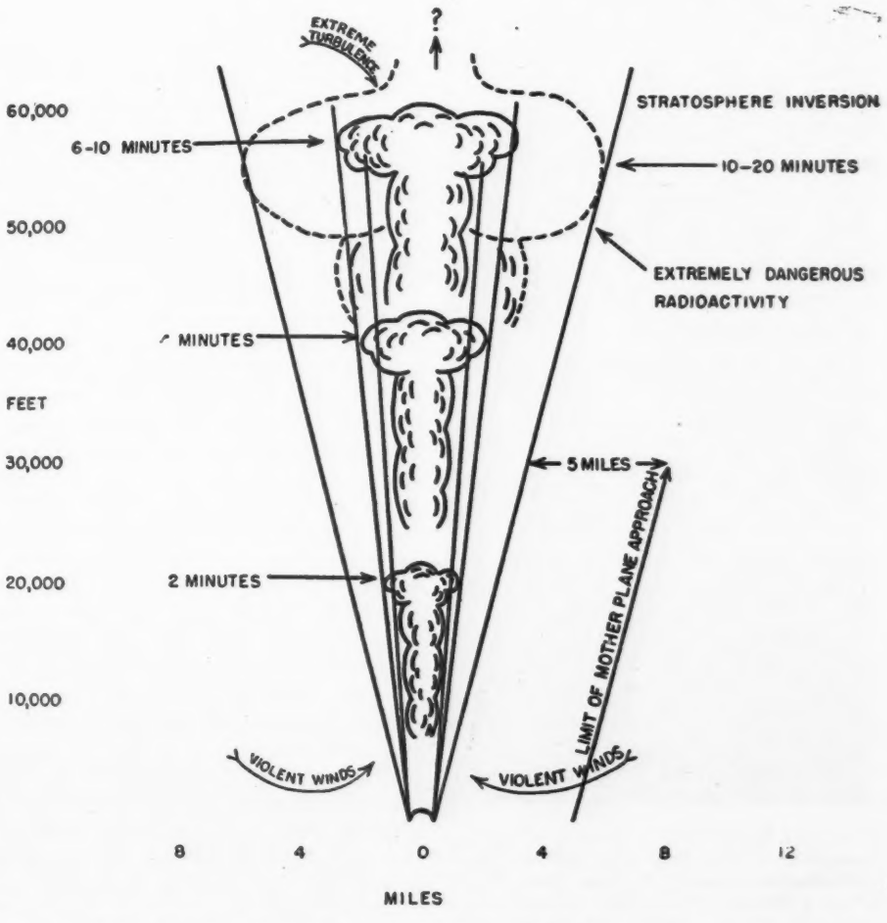
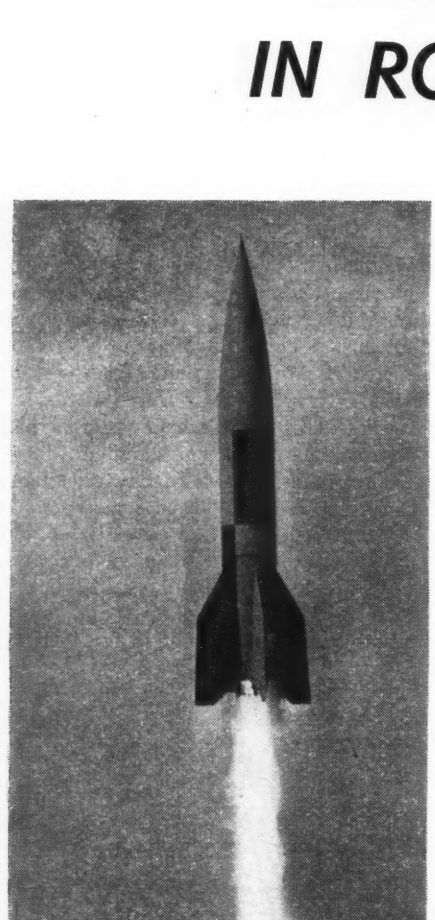


Blast cloud will be particular object of study at Bikini. Sketch shows probable position of rising cloud at intervals after explosion. As noted, "mother" planes guiding drones will not fly into danger area in immediate vicinity of blast. (Joint AN Task Force 1 photo)

CAN WE CATCH UP IN ROCKET RESEARCH?



Captured German V-2 rocket—assembled and prepared for launching under German supervision—soars skyward at White Sands, N. M. Proving Ground. Its warhead replaced with a "peacehead" of scientific instruments, rocket helps U.S. learn now what Germans started to learn twelve years ago when they began guided missile program. (Press Assn. photo)

By E. J. TANGERMAN, *McGraw-Hill Representative at White Sands Rocket Tests*

An eye-witness account of V-2 and "WAC Corporal" launchings points up need for continued research and development in guided missile program—especially important in view of atomic developments.

IT HAS BEEN BUT a remarkably short time since a workaday reporter could have a terrifying day by going to Aberdeen Proving Grounds to watch the firing of a 16-in. gun. But then American military science caught up with—and passed—Buck Rogers with the Bazooka, Super-Bazooka, Mousetrap, Minnie Mouse, Holy Moses, Tiny Tim, Xylophone, Calliope, Grand Slam, Woofus, Whiz Bang, Honeycomb and Snake; all innocent-sounding names for super-lethal rockets and rocket launchers.

But the most spectacular rocket of all still is the Nazi V-2, which was demonstrated for some 40 newsmen, photographers and movie cameramen—and again as many top military men—at White Sands Proving Ground, N. M., on May 10.

Curiously enough the rocket is not a new weapon, but a modernized one. The Chinese launched rockets against the Mongols in 1232; rockets were a terrorizing weapon in Europe 100 yr. later. Cannon outmoded them—until native Indian troops used them against the British toward the close of the 18th century. Following traditional military procedure, the British developed rockets of their own, and used them against Napoleon and against Fort McHenry in Baltimore to help a certain poet named Key write the "Star Spangled Banner." Only 32 yr. later— 100 yr. ago—the United States Army created its first rocket battery. We used pinning rockets against Mexico at Vera Cruz and in storming Chapultepec, then gave them up. The rise of the airplane in World War I suggested rockets again, but it was not until World War II that they came back—and with a vengeance.

"Vengeance" was the word that gave the German A14 rocket its propaganda title "V-2". It differs from military predecessors in being liquid-fueled, and in being far larger. Our largest rocket, the WAC Corporal, is a foot in diameter, 16 ft. long, and weighs 700 lb. at launching; the V-2 is 5 ft. in diameter, 46 ft. long and weighs 28,000 lb. (Its powerplant was analyzed in detail in last month's AVIATION—p. 63—By Ray Healy, AAF rocket consultant.)

As a weapon, the V-2 was of limited strategic significance—it was very costly considering its small payload, limited range and accuracy. But the development of the atomic bomb changes the picture; now development of accurate long-range missiles is of extreme importance. Literally, the sky is the limit, for the Ordnance Dept. is building test equipment for rockets ten times as big as the V-2—a temptation for designers to devise them. And consider for a moment the production from only one German plant—the underground unit at Nordhausen—which turned out 900 V-2's per month. With atomic warheads, they'd have been vengeance weapons and no mistake.

The V-2 was no sudden development; it took 12 yr. by the best available German scientists and millions of dollars. We are now capitalizing on this work to obtain fundamental information which will help us develop better, longer-range missiles. To speed the job, we brought over parts for some 25 V-2's and placed in "protective custody" a number of German scientists connected with guided-missile research for over ten yr. at Peenemunde. These scientists are now working quietly at White Sands indexing and translating captured documents (thank goodness, the methodical Germans record *everything*), identifying rocket material, assisting in assembling and firing V-2's, and providing technical information on rocket design. They have also assisted in training the detachments assigned for handling, firing and

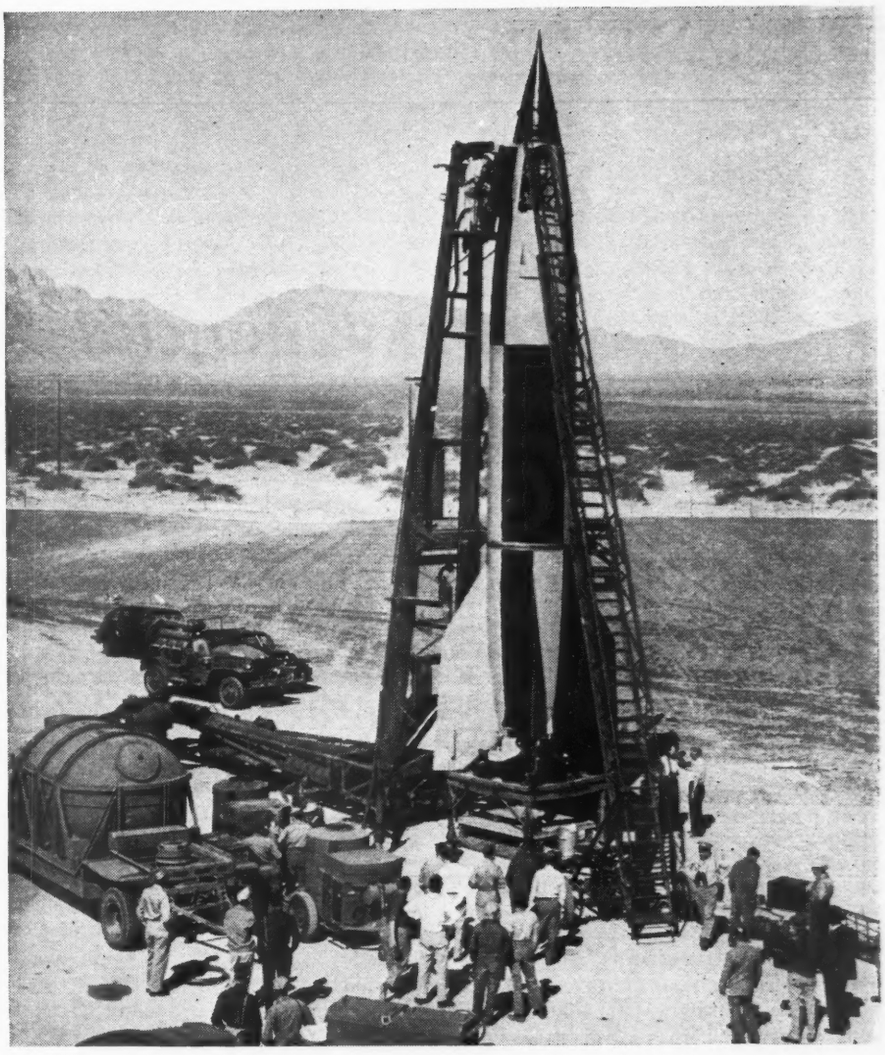
tracking the rockets, and in setting up portions of the elaborate system of synchronized radio, radar, photographic and visual equipment used to observe and record the behavior of the rockets in flight. These scientists are under contract for a limited period, their nominal salaries going to their families in Germany. They are allowed no access to our own classified projects, and leave their designated area only with military escort. Those I talked to were happy as clams with their giant toys, and would like to stay here.

To assemble the V-2's, replace missing parts, repair damaged ones and provide fuels, General Electric has been employed. This permits a variety of additional test objectives, including testing of alternate components, use of radar in tracking and in countermeasures, developing of instrumentation and studying of trajectories, upper-atmosphere physics and the like.

To accomplish these objectives, the warhead of the V-2, with its explosive filling, becomes a "peacehead" filled with scientific paraphernalia for exploring the upper atmosphere and for evaluating the performance of the propulsive system and automatic controls of the rocket. The fuel supply used by the Nazis to fire rockets into London from launching areas more than 200 miles away on the continent, over a trajectory reaching a height of 60 miles, can, when the automatic controls are set properly, send them up to twice that height in a very nearly vertical trajectory ending in a safe impact area within the Proving Ground.

In current tests the height attained will be about 100 mi. The V-2 launched May 10 went 72 mi. (127,000 yd.) high and landed 39 mi. from the firing point. Fuel remaining when burning was terminated by remote control exploded on impact, gouging out a hole 20 ft. deep and 30 ft. across and burying the head in hard clay and gypsum sand. Actually, the 10 tons of fuel in a V-2 has more energy content than its 1800-lb. warhead by many times, even the remainder frequently matching the warhead in power. Lateral error was only 340 yds., or about 0.5%.

As fired against London, about 14,000 lb. of gas expelled at an average velocity of 6800 fps. gave about 10,000 lb. of rocket and unburned propellants a forward velocity of 4900 fps. when the fuel supply was cut off and burning ceased. This happened about 60 sec. after take-off when the rocket had travelled 25 mi. along its trajectory and was moving in a direction 47 deg. away from the vertical, i.e., 43 deg. above the horizontal, at a point 17.5 mi. above the ground and 15.5 mi. longitudinally from the launcher. The normal trajectory started the fourth second, fuel was cut off at 67 sec. and 3,440 mph., 22 mi. from the launcher and 24 mi. in the air. Maximum elevation of 50.8 mi. was reached at 176 sec. and 147 mi. and impact was at 306 sec. and 182 mi. This takes the V-2 through the troposphere (to 40,000 ft.), the stratosphere (40,000 to 270,000 ft.) and into the Heavyside layer (270,000 to 320,000 ft.) The May 10 shot went beyond the ionosphere, establishing an American record of 360,000 ft.



V-2 is rigged for launching at White Sands Proving Ground. Note carrying trailer and cradle used for raising rocket into vertical launching position. Mobile tank at left contains alcohol which forms part of fuel.

During the burning period, direction of the rocket is controlled by the action of four movable vanes on the fins and four graphite ones in the jet—the latter essential during the low-velocity starting period when the fin vanes have no aerodynamic effect. Vanes 1 and 3 in both groups are in tandem to control roll and yaw. Vanes 2 and 4 in the jet path control pitch, while fin vanes 2 and 4 act as stabilizers. The 1 and 3 vanes and stabilizers 2 and 4 (independently motored) are controlled by a gyroscope to maintain the axis of the rocket in the vertical plane through the launching and target points, thus keeping the rocket heading in the right direction.

Jet vanes 2 and 4 are controlled by another gyroscope to produce and maintain correct inclination of the trajectory during the burning period. This second gyroscope is subject to the control of a third gyroscopic system, the real brains of the missile, which serves to maintain vertical travel to a height of about one mi., then to tilt the rocket slowly away from the vertical until it travels on the desired course, thereafter to maintain this course until the velocity is correct for the range desired, and finally, to cut off the fuel supply at that velocity, thus ending propulsion. Fuel cut-off can also be accomplished by remote control from the ground. After jet propulsion has ceased, the rocket behaves

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FINANCE

Sound Financial Status Braces Industry in Readjustment

BY RAYMOND L. HOADLEY, *Financial Editor of "Aviation"*

Our annual survey reveals that manufacturers' resources are now tiding firms through two-year realignment period, with gloom banished by a $90 million reconversion reserve and low inventories. Accordingly, the industry now rises out of the survival stage to initiate true profit-seeking.

THE AIRCRAFT INDUSTRY can't get away from its wartime habit of setting new high records each year.

Granted, our annual survey shows that sales and earnings were somewhat lower in 1945 than in 1944. But the industry's collective balance sheet shows a new high record of financial strength and resources for America's No. 1 security industry.

This sixth in our series of annual financial surveys of the aircraft industry is probably the most significant since, among other interesting data, it reveals one particularly salient fact:

The aircraft industry today has sufficient financial resources to carry it through the remaining year or two of postwar readjustment, while meantime the American people and Congress decide (1) what they want in the way of a future air force and (2) what degree of strength is accordingly requisite in the aircraft industry.

The plane makers have done much more than merely maintain solvency. They have gone ahead and gained a position of financial soundness—thus confounding the experts and their friendly critics both within and without the industry.

You will remember with a shudder those statements made by well-meaning observers a little time back—that the industry wouldn't be able to meet more than two weeks payrolls after the war ended. Some feared that huge inventory losses would cut balance sheets to shreds.

Quite rightly, there was much talk of the coming "financial distress" back in '44, when the industry's problems seemed over-powering. It was thought in some circles that a huge amount of financing would be required during the reconversion period.

Those Three Risks

Researchers of one leading university made a study of the financial condition of leading aircraft concerns—and came to the conclusion that the industry faced three major risks right after the war:

1. Existing corporate resources might prove inadequate to absorb losses resulting from contract termination and inventory liquidation.

2. Subsequent costs of contraction and

THREE-YEAR COMPARISON OF

	Sales			Net Income			Readjustment Reserves		
	1945	1944	1943	1945	1944	1943	1945	1944	1943
Aeronca	$4,974,212	$4,768,502	$12,078,638	$106,036	$145,831	$204,546	$196,000	$213,700	$158,000
Aviation Corp.	.....	61,259,997	45,503,638	.....	3,106,179	4,723,894	.....	600,000	1,400,000
Beech	123,751,822	90,103,000	89,826,000	3,722,402	2,705,481	2,216,596	.....	.....	.....
Bell	270,416,614	317,473,879	232,134,628	4,465,297	3,156,975	2,462,414	4,200,000	3,600,000	.....
Bellanca	8,902,832	6,652,982	6,122,492	273,631	291,862	332,227	.....	.....	.....
Boeing	421,147,917	608,082,413	493,188,161	6,488,705	5,257,522	4,482,870	16,575,400	2,680,000	2,500,000
Cessna	.....	40,386,000	70,729,401	.....	1,102,000	2,208,000	.....	.....	831,000
Consolidated	645,053,838[1]	960,016,000	800,578,000	7,028,932	12,424,000	12,279,000	.....	6,500,000	13,100,000
Curtiss-Wright	212,588,000[2]	1,716,935,177	1,295,236,317	.....	14,331,062	12,883,347	32,831,000	24,311,000	15,223,000
Douglas	744,682,664	1,061,407,485	987,687,196	8,955,754	7,685,227	5,952,257	15,652,000	8,789,000	6,950,000
Fairchild	41,831,481	93,212,963	102,450,364	688,034	1,173,123	1,827,211	3,587,102	2,500,000	1,200,000
Grumman	236,846,862	323,749,331	278,695,001	5,713,528	9,550,001	4,643,200	4,500,000	2,000,000	1,300,000
Lockheed	.....	603,363,664	669,152,490	.....	4,522,848	7,988,420	.....	1,057,000	9,000,000
Martin	.....	533,400,444	598,072,796	.....	4,909,572	2,988,456	.....	14,500,000	10,000,000
North American	.....	718,003,499	509,139,600	.....	8,389,967	6,790,323	.....	7,000,000	5,000,000
Northrop[3]	86,413,350	88,045,089	69,791,844	747,501	603,516	1,249,535	.....	163,000	.....
Piper	7,700,850	3,230,087	4,679,507	143,152	157,823	210,883	81,000	33,000	162,000
Republic	222,148,329	369,593,425	282,581,687	1,889,778	2,812,186	3,025,954	4,357,000	1,450,000	2,844,000
Ryan[4]	43,003,000	40,085,433	25,357,541	244,896	703,345	597,312	621,700	639,000	250,000
United	484,310,503	743,527,683	733,590,668	12,855,280	15,562,335	15,396,114	35,346,000	36,078,000	30,205,000
Waco	13,388,261	12,046,603	14,660,590	92,328	106,543	120,681	30,000	31,000	106,000

[1] All 1945 figures preliminary. [2] Last 6 mo. of 1945 only. [3] For fiscal yr. ended July 31. [4] 1945 figures for first 9 mo. only.

conversion might consume a substantial part, if not all, of available funds.

3. Remaining capital, together with that which the firms appeared capable of raising, might prove inadequate for maintenance of peacetime employment and production.

That's what the professors (and many others) thought when the outlook admittedly appeared tough. Here, however, is the way the industry's financial cards actually stacked up at the beginning of 1946:

Despite the fact that reconversion had begun, postwar reserves were substantially larger than they were at the start of 1945.

Cash and net working capital jumped ahead, while current liabilities declined and the figure for bank debt showed little change.

Inventories were down 50% (or more in some cases) from their wartime peak. Dividend payments declined only slightly, and profit margins on sales continued among the lowest of America's great industries.

Let us consider a more detailed survey of the aircraft financial facts of 1945 and their relation to the present readjustment period:

Inventories of reporting companies aggregated $86,888,610, last year against $124,565,000 in '44 and $138,050,000 in '43. The large manufacturers appear to have their inventory situation well in hand; while, given availability of materials and parts, some of the smaller, personal plane makers would like decidedly larger inventories than they do have.

Last year's sales by the reporting concerns were $3,567,160,535, against '44 sales of $4,722,084,823 and $3,257,933,250 in '43. The decline, of course, was to be expected in view of the multitude of contract termination orders that flowed from Washington following V-E Day and again after V-J Day.

Net earnings for the group, however, stood up much better than might be expected, totaling $53,415,254, against $57,628,686 the previous year and $40,894,540 in '43.

Tax charges last year came to $140,964,000. There was a time when some questioned the industry's ability to meet its taxes when the war was over. Yet the industry seems to have ample cash resources to meet the tax collector's demands.

Perhaps the most promising feature of the industry's composite balance sheet for 1945 is its rainy-day reserve. The companies reporting had, at the year-end, contingent reserves of $117,977,202 to use for reconversion or readjustment. In fact, such reserves were more than $35,500,000 higher than in '44 and $47,000,000 higher than in '43.

Some companies drew down a bit on reserves late last year, but not enough to make much of a dent in the large totals most concerns accumulated during the war years. It is already evident that most companies will not find it necessary to use these rainy-day reserves during their reconversion period. The result is that during 1946 the management of such companies as Douglas and United Aircraft—to cite only two—will have to decide on what permanent disposition to make of these specific funds.

Turning to other balance sheet items we find that current assets of the reporting companies last year were $639,835,000, against current liabilities of $343,890,000. That leaves an aggregate net working capital of $295,945,000—and that's more than pin money.

To be on the safe side, most aircraft companies negotiated huge V, VT, or T-loans during the war years. Such agreements made available some $600,000,000 to the industry for financing war contracts or terminations. But the industry found surprisingly little need for such credit, due largely, we presume, to the government's program of making partial or advance payments on terminated contracts. Anyhow, at the end of 1945, bank debt for the reporting companies came to only $13,704,000.

Last year, survival—not profit-making—was the main objective of the industry. That's not true today, except perhaps in the case of some struggling personal plane companies which are either entering production for the first time or are not abundantly supplied with cash resources.

As for the others, there will be no casualties, at least until their current cash cushion is used up. But, because of the great present-day expense in developing and producing new models, the balance sheets of some aircraft makers may not look as good a year from now as they do today.

Admittedly, the earnings outlook this year is none too promising. One company had a loss of nearly $1,000,000 at the end of the first two months of 1946. Yet while some firms may just about break even on the year, on the other hand there are a few that may show quite profitable operation.

Poor profits in '46 are symptomatic of the readjustment period, in the judgment of the industry—which now presses forward intent on making sure they are only symptomatic.

LATEST UNFILLED ORDERS

Boeing	$90,000,000
Consolidated	210,000,000
Curtiss-Wright	86,000,000
Douglas	219,000,000
Fairchild	78,300,000*
North American	75,000,000
Northrop	53,500,000
Piper	12,000,000
Republic	45,276,000
United Aircraft	110,000,000
Total	$974,076,000

* Exclusive of letters of intent of approximately $2,250,000.

21 AIRCRAFT MANUFACTURERS

Cash & Bonds			Earnings Per Share			Dividends			
1945	1944	1943	1945	1944	1943	1945	1944	1943	
$556,300	$1,255,000	$203,000	$0.41	$0.93	$1.55	$0.10	$0.10	....	Aeronca
.....	10,458,000	7,994,000	.....	0.54	0.46	0.20	0.20	0.20	Aviation Corp.
14,867,000	8,561,000	16,158,000	9.30	6.76	5.54	1.00	1.00	1.00	Beech
26,790,000	27,262,000	16,456,000	10.30	8.01	6.25	1.00	1.00	1.00	Bell
406,000	707,000	640,000	1.10	1.27	1.44	0.50	0.50	0.50	Bellanca
41,071,000	11,036,000	10,345,000	5.99	4.86	4.14	1.00	2.00	2.00	Boeing
.....	2,225,000	23,300,000	.....	1.57	3.15	0.25	0.40	1.00	Cessna
.....	56,938,000	66,724,000	4.92	8.80	8.67	2.00	2.00	1.50	Consolidated
.....	237,531,000	258,085,000	.....	1.62	1.42	0.50	0.75	0.75	Curtiss-Wright
46,832,000	31,701,000	41,300,000	14.93	12.81	9.92	5.00	5.00	5.00	Douglas
3,826,148	3,192,000	3,966,000	.34	1.12	1.75	0.20	0.20	0.20	Fairchild
29,902,000	13,142,000	19,313,000	11.24	18.80	6.58	1.50	1.50	1.50	Grumman
.....	27,440,000	67,400,000	.....	4.20	7.42	2.00	2.00	2.00	Lockheed
.....	41,634,000	65,750,000	.....	4.37	2.68	3.00	3.00	3.00	Martin
.....	78,023,000	72,614,000	.....	2.44	1.98	1.00	1.25	1.00	North American
2,104	4,485,000	.....	1.85	1.50	3.13	0.25	0.25	0.40	Northrop
360,000	1,036,000	200,000	0.21	0.27	0.36	....	0.12	....	Piper
15,348,000	16,336,000	16,686,000	1.92	2.86	3.08	0.50	0.50	0.25	Republic
1,039,000	3,116,000	1,919,000	0.59	1.60	1.36	0.15	0.35	0.35	Ryan
92,000,000	98,677,000	72,433,000	4.35	5.37	5.30	2.00	3.00	3.00	United
294,000	816,000	1,295,000	0.64	0.73	0.83	0.30	0.30	0.30	Waco

What Does It ACTUALLY Cost To Fly Your Plane?

PART V OF A SERIES

Carefully considering direct, fixed, and operation expenses—along with the highly relevant depreciation factors—the author demonstrates that in any forthright calculation the upkeep outweighs initial cost, while hours flown afford an outstanding criterion.

By CHARLES A. PARKER,

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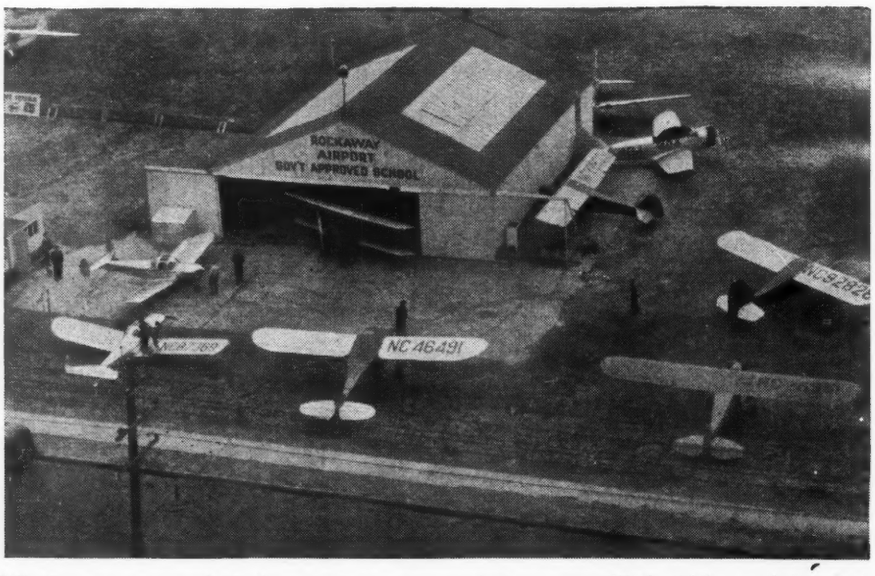
IN A COMMERCIAL aircraft operation, knowledge of costs is essential in order to establish a yardstick by which the operator can determine the adequacy of his rates. In the past, many operators have failed to make correct estimates of their costs of operation; they have frequently established rates in accordance with what the other fellow has charged, or upon some arbitrary figure, rather than through use of their own particular factors.

While such procedure may "work out," the truly progressive operator will build better business by employing a more concrete basis upon which to predicate his charges. The operator who handles aircraft sales will be interested in this subject because he must answer questions from prospects relating to cost of ownership by quoting data that are complete and authentic. In the operation of aircraft, the cost problem is similar to that encountered in the use of any other machine, in that total cost of operation per hour varies with the amount of use.

There are certain costs continuing even when the airplane is idle. These may be called "fixed expenses" because they remain constant over a considerable period. They can be considered as overhead when the machine is privately owned and operated, but they do not encompass the overhead which is encountered when the airplane is operated commercially, for then other items must also be considered.



Whether you own a rebuilt Army trainer or a new airplane, you still should know what it costs you per hour to fly your own airplane. (photo by Clarity)

Costs incurred when an airplane is flown may be considered "direct operating expenses," and their total will vary directly with the number of hours flown.

Total costs of aircraft operation are thus the sum of fixed and direct operating expenses; and to determine what it will cost to operate the airplane, a number of factors must be known and others must be assumed to make any reasonable prediction. Direct costs can be reasonably well estimated when local prices for fuel and maintenance are known, from which a figure can be set stating the outlay on an hourly basis. Fixed expenses, however, will depend upon the method of computing depreciation, the amount of insurance, and hangar rent. In addition, any increase in rates of the flyer's personal insurance incurred as a result of owning and flying an airplane should be considered in the total cost of ownership.

Since this last item is of a personal nature, the amount involved will vary considerably with the type of insurance. Accordingly, it will be omitted from our present calculations. Further, where dollars and cents figures are given, they are only for purposes of illustration, though they represent typical values.

Direct Operating Expenses

Expenses incurred when the airplane is flown include charges for gasoline, oil, maintenance, and overhaul. The example given here is based upon some retail figures that might be encountered by a private owner. In considering the cost of commercial operation, wholesale figures would of course be used.

The cost of gasoline and oil needs no explanation. Maintenance costs, in the event of changes in CAR, will probably be lessened. Whereas prewar regulations required that certain checks and inspections be done by licensed mechanics, the owner is now permitted to do more of the work himself. Because of improvements, power plants in the lower hp. classes

now afford some four years of operation —if we measure with the "yardstick of average use". Not only have these engines stood up well, but top overhaul is now seldom necessary, while the average time between major overhauls has been extended. CAA figures that $0.89 per hour is cost of maintenance, replacements, and mechanics' services for the average lightplane, to which 15% will be added in order to approximate retail costs, which will bring this item to $1.02.

The owner should not overlook the fact that other miscellaneous service expenses may be incurred from time to time. Maintenance costs are not always as low as may be glibly claimed by the aircraft salesman. Addition of equipment to an airplane is not a cost of operation but an increase in the value of the airplane itself.

Table I — Depreciation of Aircraft

Period	Percentage Write-Off	Value in Percentage of Original Price
New	None	100
End 1st yr	20–35	70–80
End 2nd yr	35–50	50–65
End 3rd yr	45–60	40–55
End 4th yr	55–70	30–45
End 5th yr	65–75	35–25

The following estimate is based upon direct cost of flying a typical privately owned 60–75 hp. plane:

Gas, 4 gal./hr. @ .25/gal.	$1.00
Oil, ½ pt./hr. @ .32/qt.	.08
Maintenance & repair	1.02
Total cost per hr	$2.10

Fixed Expenses

Fixed expenses will be considered on the basis of a yearly total, later combined with direct expenses to arrive at the overall expense. Under fixed expenses are such items as the following:

Storage, which goes on regardless of whether or not the airplane is actually operated.

Hangar rents, which may run from $10 to as high as $25 per month. Hangar rent of $20 per month will be considered here, with the airplane on a 12-month "active" storage basis.

Insurance, which will vary from nothing to several hundred dollars. Since an analysis of insurance is not intended at this point, we will consider that coverages are on damage to the airplane (hull insurance), public liability, and property damage. The figure of $322.50 for such combined coverages is a current quotation (Apr. 1, 1946) on an airplane costing $2,400.

Depreciation, which is present from the day an airplane is purchased until its eventual disposal. In the course of time, the private airplane owner will sell his plane for price less than he originally paid for it, and the loss will be part of his operating expense. If the owner be an operator, he should have made an allowance for this depreciation, and in so doing have created another asset (cash) that will enable him to make a replacement without capital outlay.

Table II — Cost Per Hour vs. Hours Flown

Hr. Flown	Fixed Expense	Direct Cost	Total Cost	Cost Per Hr.
10	$1,042.50	$21.00	$1,063.50	$106.35
50	1,042.50	105.00	1,147.50	22.95
100	1,042.50	210.00	1,252.50	12.53
200	1,042.50	420.00	1,462.50	7.32
350	1,042.50	735.00	1,777.50	5.08
500	1,042.50	1,050.00	2,092.50	4.19
700	1,042.50	1,470.00	2,512.50	3.59

Figuring Depreciation

Straight line method. By this system, the airplane is depreciated on the basis of a certain number of years of useful life. The Bureau of Internal Revenue indicates that a 5-yr. writeoff for private aircraft is acceptable; however, at the end of that time the airplane most certainly retains a residual value. A steep writeoff is unnecessarily hard on an operator. In fact, CAA considers a period of 10 yr. as fair, because it more nearly accommodates the actual situation. The average life of non-scheduled civil aircraft has been 7.4 yr., including destruction as a cause for cessation of use.

Writeoff on an hourly basis. This method, which predicates a certain working life, and which becomes a straightline method with regular use, is not recommended unless the plane is used on a uniform basis over a long period.

Declining balance method. This type of writeoff, based on a lessening percentage of original value, more nearly gives the true worth than the other two systems. Here, the values tend to keep pace with the market prices. With the introduction of yearly models, airplane values tend to depend more upon age than upon the number of hours flown. The plane does not, however, depreciate at a fixed annual percentage.

To explain: The highest percentage is deducted in the first year of the craft's life, with a gradual lessening of this amount as the plane grows older. Hence, at any time the plane will have some value. The method is similar to that found in both the automobile and the machinery fields. An actual case will be of interest—

The plane in question originally sold for $7,000. It was flown for only 40 hr., then remained in dead storage for 2 yr. At the end of that time it was sold for $3,600—slightly more than half of its original value. Had this airplane been considered on the basis of an hourly writeoff, it would have decreased but little in value. If it had been depreciated on a 5-yr. basis, it would have shown a value of $4,200 at the end of 2 yr., while on the basis of 10 yr. it would have shown a paper value of $5,600 at the time of sale. Obviously, these last two figures were not in line with the market, but the interesting point is that the plane would probably have brought almost as much had it flown 140 hr. or even 200 hr. as it did at 40 hr.

In one recommended practice, the airplane was considered to depreciate in 5 yr. to approximately one-third of its original value. Writeoff here would be one-fifth of the difference, or about 13½% per year. This again gives a straightline depreciation for the first 5 yr. and appears slightly low for the first year if a yearly change in models should become customary. In this accounting, an operator may decide to use the 5-year writeoff basis. But in sales he should use the percentages given in Table I, since careful determination of depreciation and market price then becomes essential.

Total Fixed Costs

On the foregoing basis fixed costs for the first year would be:

Hangar storage @ $20.00/mo.	$240.00
Insurance (hull, public liability, property damage)	322.50
Depreciation @ 20c. (on $2,400 plane first year)	480.00
Total fixed costs	$1,042.50

Total Cost of Operation

We can now estimate total cost of operation by the following formulas: Total cost of operation = fixed expenses + direct operating expenses, while the cost per hour is obtained by dividing fixed expense by hours flown and adding

Table III — Effect of 50% Reduction In Storage and Insurance Rates

Fixed Cost / Flight Hr.	Direct Cost / Flight Hr.	Reduced Cost Per Hr.	Former Cost Per Hr.	Percent Saving Over Former Cost
$\frac{761}{200}$ = $3.85	$2.10	$5.91	$7.32	19.3
$\frac{761}{350}$ = $2.17	$2.10	$4.27	$5.08	15.9

Table IV — Comparison of Operating Costs

Flight Hr.	Lightplane	Plane A	Plane B	Plane C
100	$12.53	$19.17	$29.82	$35.12
200	7.32	10.92	17.07	20.57
350	5.08	8.17	11.62	14.34
500	4.19	5.97	9.32	11.84

Lightplane is type already discussed.
Plane A is 90-hp. 2-place 110-mph., costing $4,000; direct exp. $2.67/hr., fixed $1,650 yr.
Plane B is 145-hp. 4-place 120-mph., costing $7,000; expenses $4.32 and $2,550.
Plane C is 245-hp. 4-place 140 mph., costing $8,000; expenses $6.02 and $2,910.

Table V — Cost Per Seat-Mile for Various Size Planes

Type	Cost Per Hr. / Cruising Speed	Cost Per Mile	Cost Per Mile / No. of Seats	Cost Per Seat-Mile
Lightplane	$5.08 / 90	5.6c.	5.6c. / 2	2.8c.
Plane A	$8.17 / 110	7.4c.	7.4c. / 2	3.7c.
Plane B	$11.62 / 120	9.7c.	9.7c. / 4	2.4c.
Plane C	$14.34 / 140	10.02c.	10.02c. / 4	2.5c.

direct hourly cost of $2.10 in each case.

Cost per flight-hour is reduced materially as the amount of flying is increased. This cost reduces most rapidly during the initial hours, with a gradual lessening to the point where there is but little reduction, even with a large increase in the number of hours flown (the period from 500 to 700 hr. for example). For full appreciation of this reduction of the cost of operation, note the figures in Table II.

It can readily be argued that expenses of the private plane rise high with low usage. The type of a plane upon which these figures are based can be hired for from $6 to $10 per hour. With $8 taken as an average, it could be said that up to nearly 200 hr. it would be cheaper to fly on a rental basis than to own.

Comparison of Costs

It is obvious that once hangar rents and insurance coverages are materially reduced, not to mention the initial cost of aircraft themselves, private ownership will become much more attractive than at present. With a 50% reduction in storage costs and insurance, for example, the fixed expenses would be reduced from $1,022.50 to $761 for the year and then comparative costs for 200 and 350 hr. per year would run as in Table III.

A more favorable presentation of costs could be made on the basis of tie-down and no insurance, but most owners prefer to store their airplanes, and lack of insurance protection is not sensible economy.

The foregoing discussion has revolved around the lightplane, but what of the larger aircraft? Three types of airplanes, in addition to the lightplane already considered, are compared in Table IV.

The substantial costs involved indicate the need for the operator to analyze income possibilities carefully before investing in larger and more expensive aircraft. On the other hand, when assured of regular usage and sales on a "per-seat" basis, it is interesting to find what a favorable showing larger aircraft can make.

This is evident in Table V where a usage of 350 hr. per year has been taken for illustration. Particular attention is called to the favorable cost per seat-mile in the case of larger craft. To enjoy such an advantage all the seats would have to be occupied.

The advantage of parties chartering larger aircraft for round trips is also brought out in Table V. Three persons flying cross country with a commercial pilot would still enable a rate of 3.4c. per seat-mile for the largest plane shown, making favorable comparison with the average airline fare of 4c. per mile. For a private owner flying his own airplane with all seats occupied, the rate of 2.5c. per seat-mile for the largest aircraft would apply, making an even more favorable comparison.

A final point in connection with costs is that of rate reductions with increases in cruising speed, other factors remaining constant. Take the case of the lightplane: With an increase in cruising speed of from 90 to 122 mph. (about 20%) there would be a reduction in cost from 5.8c. to 4.6c. per mile, or more than 1c. The interesting possibilities of lowered costs, attendant with the challenge to the manufacturers, can be fully appreciated when reductions become possible through the lowering of insurance and storage rates, as well as through increased performance. At present, fixed expenses constitute one half of the total expense up to about 500 hr. of flying. This situation must be improved if aircraft ownership is to become widespread.

It is not uncommon for the aircraft salesman to be asked for a comparison of aircraft operating costs with those of other vehicles. An excellent analysis, developed in 1938, enables some revealing comparisons to be made (see Table VI). Two types of aircraft were chosen in the class of planes A and C of Table V. A 35-ft. motor boat and also a motor car were then brought into parallel. Charges for fuel, storage, and repairs were made according to costs current at that date. Depreciation was calculated for the planes and car at 25% and for the boat at 15%. Insurance charges were below those used in the preceding discussion. (These variations are not important, because as long as conditions are as similar as possible and in line with current usages, the comparison will be of value.)

It was assumed that the planes were used on trips of 50 mi. or more, while operation of the car was based upon suburban travel including trips up to 50 mi., and use of the boat was judged as being in the short cruise and harbor spin category.

Particularly favorable is the per-mile comparison between the small plane and the car. The striking operating-cost differences between aircraft and the yacht should be valuable data to every aircraft salesman. Not many persons engaged in aviation realize that such considerable variances exist between these two specific units.

Little in the way of a hard and fast statement can be made that aircraft are cheaper to operate than this vehicle or that one, because much depends upon the factors involved, and upon the basis on which comparisons are made—i.e., mileage, the hourly basis, or the per seat basis.

The salesman should exercise caution when it comes to making statements about the cheapness of aircraft, or else he may find himself in an embarrassing situation, though it is evident that there are extremely favorable situations for comparison and that there are types of operation in which the plane is predominantly suited for performing a certain activity at a favorable cost level.

Table VI — Cost Comparison Between Aircraft, Automobile, and Motorboat

	Aircraft (90 hp.)	Aircraft (245 hp.)	Automobile Sedan	Motorboat 35-ft. Cruiser
Value	$3,884	$9,000	$3,920	$6,000
Use/Yr.	450 hr.	450 hr.	11,250 mi. at 25 mph. (200 hr.)	1,800 mi. (150 hr.)
Cost/Hr.	$5.63	$11.53	$3.98	$13.23
Cost/Mi.	5c.	9.2c.	15.9c.	$1.10

HIGHEST SEAPLANE BASE TURNS AWAY BUSINESS

By EDWARD E. THORP, *Assistant Editor, "Aviation"*

Despite gloomy forebodings from fellow pilots, Wes Stetson based his Taylorcraft floatplane 6,200 ft. above sea level—and found business already waiting for him.

WHEN WES STETSON returned from trans-Atlantic flying for ATC he decided to start his flight school where he would not be crowded. Lake Tahoe, Cal., one of the most beautiful lakes in the U. S., seemed to be unique among the few eligible sites still overlooked by operators, so he selected this body of water as his seaplane base.

Remembering that the lake is 6,200 ft. above sea level, Stetson decided to make a few inquiries about the experience of others who had tried flying off the surface of this body of water. First impressions were not encouraging—two amphibians had required dismantling to get them away from the lake. And while Frank Fuller had taken off successfully, he was flying a twin-Wasp Grumman.

"Everyone was very good about giving information," writes Stetson, "but I could always detect that look they reserve for a fellow pilot who isn't considered to be using all his marbles."

Finally, after considerable trouble, a Taylorcraft on Edo floats was obtained and flown from Oakland to the lake. The altimeter stuck at 10,000 ft., but the plane kept on climbing and seemed to have plenty of power, so Stetson decided to take a chance and "set her down" on the water. Everything worked out okay, except that it was found very difficult to visually estimate altitude above the clear, glassy water.

The resort of Nelson Salter, at Emerald Bay, was selected as a base—and business came in as soon as people saw the seaplane on the water. Though this was a flying school, the demand for charter flights could well have led to a rousing business in itself, but unfortunately, gasoline restrictions prevented this branch from being developed at that time—1944.

So far as takeoff was concerned, there was no trouble from plane, floats, and engine, though both Stetson and his instructor, Glenn Anderson, weigh over 180 lb. Only difficulty was that which is experienced no matter what the altitude—that is, taking off from flat water. With a full tank and two persons in the plane, it was necessary to rock one float out of the water until the ship was riding on only one step, after which there was no difficulty in leaving the surface.

Nelson Salter's resort at Emerald Bay on Lake Tahoe, Cal., is Wes Stetson's high-up summer base.

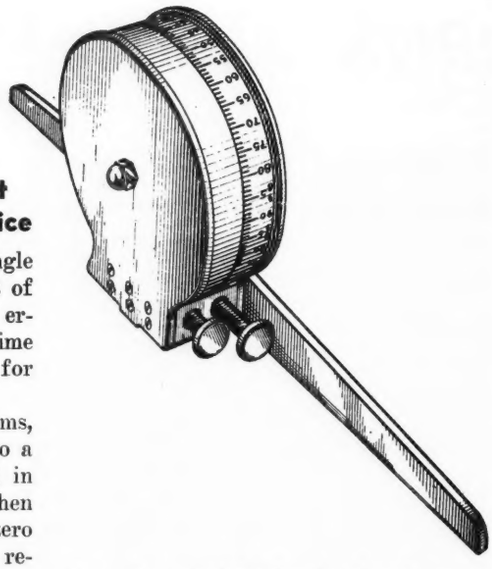
Being the only air operation on the lake, at a resort where nearly everyone has money, there was no trouble in keeping busy for as long as the pilots could stay flying. At $10 per hour there was a waiting list throughout the summer.

Dock for float repair was made by mounting plank platform on old oil barrels. This is the only part of the operation remaining from one year to next.

Problem of what to do about winter storage was simply solved—the plane was sold to a summer resident who had learned to fly and wanted to return home by air. Each summer Stetson takes up a new plane, thus solving the maintenance and overhaul difficulty neatly and profitably. The only piece of equipment which is left behind at the season's end is a dock, which was constructed on old barrels at a total cost of less than $50.

There must be many locations in this country and Canada where an operation of this type could be profitably carried on. Given a good plane of almost any of the standard makes, altitude seems to be no bar to operations, this being proved by the fact that Stetson also carried on successfully from nearby Fallen Leaf Lake, which is at least 100 ft. higher than Lake Tahoe.

WAYS & MEANS



Prop Blade Angle Measurement Sped by Gravity Operated Device

• Designed to give propeller pitch angle readings without calculation on part of mechanic and without accumulative errors, this instrument, used for some time by USN, is now being produced for civilian use.

Unit consists of two narrow drums, mounted on ball bearings attached to a straightedge. Drums are calibrated in degrees and are so weighted that, when free to move, they will turn with zero marks uppermost and together, if restraining brakes are released by pressing on buttons which control them.

When using instrument, a propeller blade is moved into a horizontal position, then straightedge is placed across blade surface at a predetermined point. Brake is then released on one of weighted drums, which turns freely until zero mark is uppermost. This drum is then locked by releasing brake button.

Propeller is then rotated through 180 deg., bringing it into a horizontal position opposite to that which it formerly occupied. Straightedge is then placed against same place on blade as previously and brake on other drum is released. Second weighted drum thereupon turns with its zero mark at top, after which brake is applied. Difference between two zero marks on drums indicates angle between two positions of blade surface. Because this angle is twice actual pitch angle of blade, one drum is marked to read in graduations of two degrees spacing, so that direct readings of blade angle can be made.

Apart from advantage of direct reading without calculation or recording of figures, instrument permits making of pitch measurements without leveling plane or fixing a datum line from which a horizontal center line can be established.

C. G. Shifter Shortens Landings

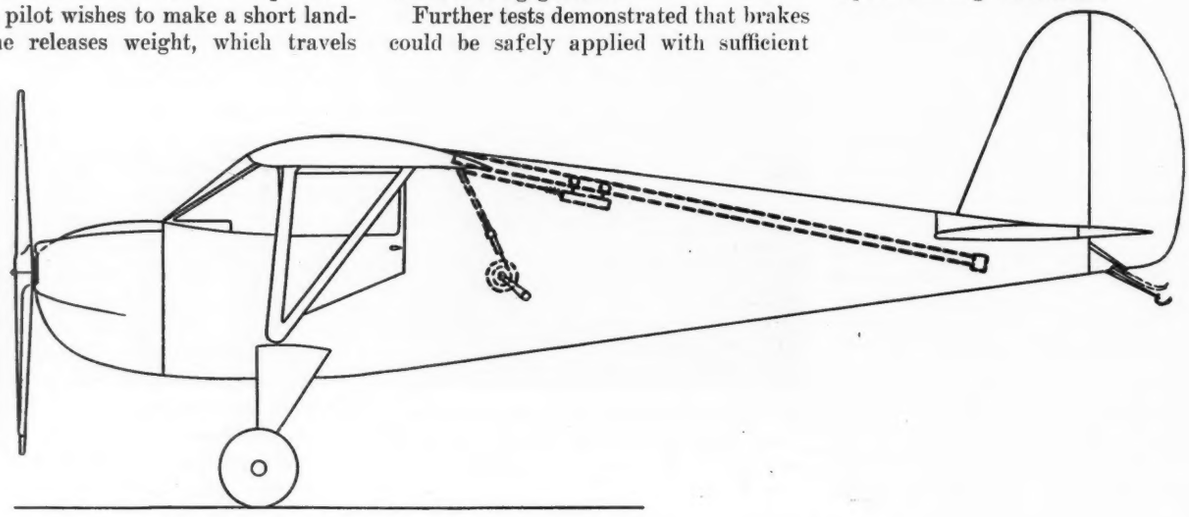
• A new accessory made by Aircraft Devices, Philadelphia, has been designed to provide that small amount of extra tail loading necessary to prevent nosing over when a short runway compels pilot to apply his brakes heavily while still traveling at high speed.

Device consists of a weight, mounted on ball bearings running on a track which extends from C.G. of plane to a point as far back in tail as possible. When pilot wishes to make a short landing, he releases weight, which travels back along track to tail, thereby changing position of C.G. of plane. Because this change makes plane tail heavy, it is necessary, before landing, to depress elevators as far as possible, thus adding to retarding effect of brakes.

Tests made before CAA and NACA officials at Wings Field, Ambler, Pa., showed that test plane—a Luscombe Silvaire, which lands at 52 mph.—could be set down and completely stopped within a 100-ft. dia. circle without tailwheel leaving ground.

Further tests demonstrated that brakes could be safely applied with sufficient force to skid wheels on dry turf. Craft also took off repeatedly with weight in rear position, this test being made to prove that takeoff could be accomplished successfully without need for bringing weight forward.

Having a total weight of 15 lb., device both lowers and moves backward C.G. of plane, so that forces tending to overturn craft act with approximately half overturning moment normally present when brakes are fully applied under high speed landing conditions.



TAGGING THE BASES

New CAA Flight School Manual

Operators interested in bringing their flight school facilities up to standard should request CAA Manual 50 on flying school rating.

Noteworthy in manual's provisions is liberalization on runway length down to 1,500 ft., only condition being that school planes be able to take off in half length, yet clear usual 50-ft. imaginary obstacle. This ruling eases cost for new airport projects, where expense of leveling long runways is major outlay. Also specified is 20-to-1 glide angle for approach.

It should be remembered that Administrator T. P. Wright states CAA has no power to compel a school to comply with its standards. Those which do not comply are generally of too low a standard to obtain CAA approval.

* TAGGING THE BASES *

First Region—Simsbury Flying Service has leased hangar at former AAF base, Bradley Field, Conn. . . . Atlantic Gulf Midland Corp., Nutley, N. J., has purchased Douglas C-47 for use as textile transport to Puerto Rico. . . . DuPont Airport, Wilmington, Del., is now being operated for civil flying by Stewart E. Poole, Atlantic Aviation Service. . . . Alton B. Sherman has re-opened Hyannis Airport at Cape Cod, Mass., and NEA stops there on Boston-N. Y. flights. . . . Earl Goekeler has completed runways at Martin-Medford Airport, Marlton, N. J. . . . Merrimack Valley Air Service, Lowell, Mass., is operating airport and seaplane base. . . . Metropolitan Glider Assn. recently held first postwar reorganization meeting, with Charles H. Gale elected as temporary chairman (see photo). . . . R. van Seinfeld has organized Atlantic Airborne Sales Co. at Huntington, L. I., N. Y., to operate airport there. . . . Gillett Welles, Welles Aviation Corp., Elmira, N. Y., will give ground school and flight courses at Elmira College next Fall. . . . New England Central Airways, with office at 299 Beacon St., Boston, has been organized to operate airports in vicinity of city.

Second Region—Clarence W. Ludwig, St. Petersburg, Fla., is first pres. of Florida ATA. . . . Fairforest Airport, Spartanburg, S. C., has been opened by Messrs. Moss, Ginn, and Brown, all former GIs. Field has two 2,300-ft. runways, 425-ft. multiple T-hangar, and brick shop. . . . E. O. Shealey is now mgr. of Newberry, S. C., Municipal Airport. . . . Titusville-Cocoa, Fla., is raising funds for construction of municipal airport.

Third Region—Minnesota Commissioner of Aeronautics, L. L. Schroeder, states that following communities are planning airport improvements: Ortonville, Park Rapids, Fergus Falls, Marshall, Winona, Owatonna, Detroit Lakes, International Falls, Hibbing, Alexandria, Cook, Northome, Grand Marais, Crookston, Pipestone, Worthington, Redwood Falls, Faribault, and Thief River Falls. . . . Aero Corp., Atlanta, Ga., is now member of NATA. . . . Harrington Air Service, operator of Municipal Airport, Mansfield, Ohio, has built $125,000 restaurant and Sky Club with glassed-in flight deck for members (see photo) . . . Evansville Sportsman Pilot's Club, Ind., has resumed operations under leadership of V. Q. Hobgood, pres.

Fourth Region—Texas Air Lines has started operation under Mgr. Cyril P. Erwin, Erwin Newman Co., Houston, Tex. Line connects that city with others in neighboring states. . . . Phoenix, Ariz., ran aerial cavalcade to number of cities in state, crossing Mexican border for welcome at Nogales, Sonora, by Governor Gen. Abelardo Rodriguez. Group was led by "Bill" Marsh, flying his con-

(*Continued on page* 50)

Conferees who attended first postwar meeting of Metropolitan Glider Assn., recently held at McGraw-Hill Bldg., N. Y. C. Temporary committee (front row, l. to r.) are: Charles H. Gale, Conn., chairman; Larry Lawrence, N. Y.; E. Thorp, N. Y.; Alexis Dawydoff, N. Y.; Lewis Hull, Pa.; Gus Raspet, N. Y.; Gus Scheurer, N. J.; and Don Lawrence, N. J. Thomas Haire, N. Y., another committeeman, was not present.

This $125,000 Sky Club at Mansfield Municipal Airport, Ohio, features second story flight deck commanding extensive view of field and surrounding country.

Lineup of over 100 planes at Palm Springs, Cal., during recent visit of Los Angeles Jr. C. of C.'s breakfast-flight group. Types of craft varied from 65-hp. lightplanes to Lockheed Lightning seen in foreground.

AS THE OPERATORS SEE IT

Maybe you've run into a sales and service snag, face some overhaul hurdle, are grappling with a flight teaching tangle, or seek guidance in the maze of maintenance. Whatever the perplexity, it's "fair shooting" here in our operators' corner. Answers, and criticisms of answers, will be paid for at AVIATION'S usual rates. Welcome, too, will be photos or sketches which "point up" the problems.

QUESTION 3.—*Which of these sources of new business do you consider best: (A) Customer goodwill, (B) billboards, or (C) local newspaper advertising? What has been your experience with these media? Have you used successfully any other method for attracting business to the airport?—D. H.*

Answer: "All three methods have their place and are most effective when used in combination. At this airport, we have the only swimming pool in the district, and we use billboards within a 10 mi. radius to tell tourists about it. When they stop for a cool dip, we sell them the idea of flying down the road for 40 or 50 mi. to choose the best scenic route for the motor trip. They then tell others whom they meet, and here the transient goodwill comes in. And for local trade, nothing brings more return than customer goodwill, but newspaper ads and notices bring quick benefits when we have something special to offer—a new model plane or a second-hand bargain for quick disposal. We get local newspaper publicity in exchange for flying the editor to neighboring towns when there are newsworthy happenings. Since someone from the airport would go in any event, to make fresh contacts, this newspaper publicity costs very little, and our local editor not only boosts our (he calls it "his") airport, but also introduced us to many prospective customers."—*L. R. Regan, Segundo Airport, Penn, N. M.*

Readers Are Invited to Answer—

Question 4.—In the initial step of our fixed base set-up, we are confronted with the problem of site expense. Do you consider that a main highway passing an airport is of sufficient advantage to compensate for the relatively high tax charges on the land, as compared to a location on a secondary road where there is little through-traffic, but where taxes are considerably lower? —A.M.

TAGGING THE BASES

verted Lockheed P-38. . . . Dallas Aircraft Sales reports Premier Oil & Refining Co., Kilgore, Tex., has purchased twin-engine Beechcraft, to be piloted by Kenneth Koelling. . . . Walter Menge of Leon Valley Airport, Tex., reports more than 50 planes now based at field, much of business coming in from Mexico. . . . Oklahoma Aviation Assn. held first postwar meeting recently.

Fifth Region—Flying Farmers of Kansas held first organization meeting at Hutchinson, under sponsorship of "Kansas Farmer Magazine", over 200 planes being flown in. . . . Missouri Aviation Corp. Kansas City, has discontinued supply business. . . . Distributors for Globe Swift: Norbert Locke, Dodge Airways, Des Moines, Iowa; Edgar Smith, Kansas City Flying Service, Mo.; Krantz Airways, Omaha; L. W. Mack, Denver; Kratz Airport, St. Louis; Ralph Hubbard, Watertown, S. D.; and Ossorghin Aviation, Reno, Nev.

Sixth Region—Philip Smookler and Eugene Kenworthy have opened new airport at San Ramon Valley, to be operated in conjunction with their sales agency at Berkeley. . . . Los Angeles Jr. C. of C. organized successful breakfast flight to Palm Springs, Cal., on Apr. 28, flying 104 planes (see photo) . . . Duarte, Cal., airpark has been approved by 3-1 vote of local board. . . . Buchanan Field, Concord, Cal., with two 5,000-ft. runways, is now being operated for civil flying, with Darrell Jensen as mgr. . . . San Bernardino County, Cal., has appointed aviation advisory board consisting of five local operators: Les Farrar, San Bernardino; Joseph Brier, Tri-City Airport; Dewey Cable, Cable-Claremont Field; George Sanford, Ontario Municipal Airport; and Wm. Natte, Needles Municipal Airport. . . . Bob Metcalfe and Slim Dever are now operating Link trainer and instrument school at Oakland Airport. . . . John H. Engel, Escondido, is establishing residential subdivision and locating auto and farm equipment businesses alongside his 5,000-ft. landing strip. . . . San Lorenzo Flying Club has been organized at Hayward Airport, Cal., members paying $50 each, thereafter flying for $3 per hour. . . . Miller Dunckel Aviation, Van Nuys, Cal., is distributor for Nelson Soaring Plane and Republic Seabee in southern Cal. and Ariz.

Seventh Region—Boise, Ida., has new airport at Blackfoot Island on Snake River. Tucker Airport at Blackfoot will be discontinued. . . . New airport construction in Idaho is reported at Shoeshone, Bancroft, New Meadows, Council, Craigmont, Bonner's Ferry, Downey, Grace, Albion, Cambridge, Nez Perce, Cottonwood, and Genesee. . . . Oregon Aviation Assn. was organized at May 7 meeting at Bend. . . . Horseshoe Flying Club has been formed at Port Orchard, Wash., by B. Bill of Bremerton, and N. E. Little, R. F. Bill, and C. M. Peterson of Port Orchard.

Canada—Quebec Airways has been formed at Seven Islands, P. Q., for charter flying. Company will fly hunters and and fishermen into interior. . . . Seaplane base is now being operated at Toronto Island Airport, Toronto.

Real Sales Clincher Is the Follow-Up

By K. H. HOLMGREN, *Advertising Engineers Corp.*

Tenacity is a sorely needed requisite in the scheme of aviation merchandising. So counsels Author Holmgren, who declares that the dealer might well keynote his pursuit of profits with the paraphrase, "Faint heart ne'er won fair sale."

THE WEARING OF THE GROOVE
"Oh well, I'll try him again tomorrow."

AN AVIATION DEALER calls two strikes on himself when he does not take the time to follow up direct sales leads—those furnished him by the manufacturer, those developed from his own advertising, or those offered by students and visitors at the field who evidence real interest by owning a plane, taking a flight course, or even going for a short pleasure hop.

A lot of money is spent on advertising every year by aircraft makers and airport operators. This investment, made to create consumer acceptance and good will, is justified only if action is taken to develop customer interest into actual sales.

There has been gross neglect in attending to inquiries received as a result of advertising. Airplane sales leads, for example, are normally received by the factory and consequently are passed on to the distributor and then to the dealer. A common dealer complaint is that many of these leads are merely from airminded youngsters and other people who currently have no reasonable use for a plane. This may be so in some cases, but the dealer can't be *certain* unless he follows up each inquiry personally and persistently. Too many fool themselves out of sales by saying, "No use making a call on this prospect—I know that he isn't in a position to buy now."

Such fallacious reasoning is one of the greatest "deflectors" to successful selling known to the aviation industry. Too often the new or untrained airplane salesman is enthusiastic and effective only on his first call. Finding the prospect lacking sufficient ready cash for an outright purchase, the salesman does not

(*Turn to page* 147)

ANDERSON AIR ACTIVITIES
5 POINT PROSPECT CARD

DATE_____

FIVE WAYS TO FIND PROSPECTS

- ☐ ON THE SALESROOM FLOOR
- ☐ FROM YOUR FRIENDS
- ☐ FROM YOUR OWNERS
- ☐ FROM COMPETITIVE OWNERS
- ☐ BY COLD APPROACH

NOTE: CHECK WHERE YOU FOUND THIS PROSPECT.

PROSPECT_____ SALESMAN_____

RESIDENCE ADDRESS_____ TELEPHONE_____ BUS. PHONE_____

BUSINESS ADDRESS OR PLACE OF EMPLOYMENT_____ BUSINESS OR OCCUPATION_____

TRANSFERRED TO SALES INSTRUCTOR_____

SHIP OWNED_____ TYPE_____ YEAR_____ MODEL PREFERRED_____

PROSPECT'S VALUATION OF PRESENT SHIP_____ SALESMAN'S VALUATION OF PRESENT SHIP_____

CONDITION_____ NO. OF ENGINE HRS._____

REASON FOR NOT GETTING THE ORDER_____ NO. OF AIRCRAFT HRS._____

WHEN DO YOU THINK PROSPECT CAN BE CLOSED_____ WHERE WAS PROSPECT SECURED— SHOW ROOM ☐ OUTSIDE ☐

REMARKS_____

REPORT ON PROGRESS OF SALE
SPECIFY REASON FOR NOT GETTING THE ORDER AFTER EACH STEP

FIVE WAYS TO SELL PROSPECTS

- ☐ FLIGHT DEMONSTRATION DATE_____
- ☐ ALBUM DEMONSTRATION DATE_____
- ☐ DIRECT MAIL DATE_____
- ☐ PROSPECT TO SALESROOM DATE_____
- ☐ APPRAISAL $_____ DATE_____

NOTE: CHECK PROGRESS OF SALE ABOVE AND SHOW DATE OF CALL.

REASON FOR NOT GETTING ORDER_____ DATE OF NEXT CALL_____

REASON FOR NOT GETTING ORDER_____ DATE OF NEXT CALL_____

REASON FOR NOT GETTING ORDER_____ DATE OF NEXT CALL_____

REASON FOR NOT GETTING ORDER_____ DATE OF NEXT CALL_____

REASON FOR NOT GETTING ORDER_____ DATE OF NEXT CALL_____

IS HE A USED SHIP PROSPECT_____ WHAT MAKE AND MODEL_____ PRICE PROSPECT EXPECTS TO PAY_____

REMARKS_____ WHAT CAN HE PAY DOWN_____

A special sales-card is a valuable part of an effective follow-up system. Above is shown both sides of card used by Anderson Air Activities of Milwaukee. This convenient 4x6-in. form not only lists ways to get prospects and sell to them, but also provides a comprehensive check on sale's progress. And when kept readily accessible, it helps to serve as an "anti-deflector" by encouraging persistence.

New Techniques Nullify Static

Just revealed, these methods developed by military services and airline help keep aircraft radio interference-free when contact is most necessary.

NULLIFICATION OF ELECTRICAL charges generated on aircraft can now be accomplished by four techniques developed by the Army-Navy Atmosphere Electricity Project, in cooperation with Northwest Airlines, following tests conducted at Wold-Chamberlain Airport, Minneapolis.

Just released from military security, these techniques include: Use of wick dischargers (such as shown in an accompanying illustration); covering of receiving antenna with polyethylene; location of antennas away from discharge points; and designing of aircraft so as to avoid discharge points.

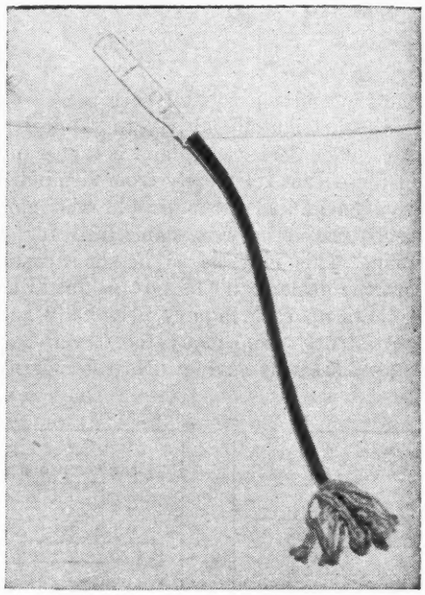
The first two methods, which are applicable to existing planes, reduce interference to such an extent that Northwest will employ them as soon as production models of the necessary units are available. The latter two, although desirable from an electrical viewpoint, cannot always be reconciled with constructional and airflow requirements.

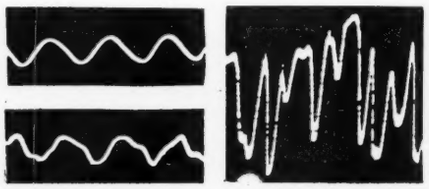
Precipitation static, a major cause of noise in aircraft radio receivers, is generated when planes fly through air laden with such particles as ice, dust, or snow, or when they pass close to electrically-charged clouds, such as thunderheads. Friction of the particles against the aircraft surfaces, or movement of the plane through electric fields set up by charged clouds, generate electric pressures which often exceed 100,000v. This pressure, after it becomes high enough, causes the familiar St. Elmo's fire or corona, which forms at wing and propeller tips, on antenna masts, and even along aerials. This corona, which causes radio interference, can be reduced by (1) draining off the electric charge while it is still so small that it causes but little interference, or (2) actually preventing it from forming where it could cause interference.

To drain the charge, the project engineers developed wick dischargers, which consist of metal ribbon and fiber cord. The many small sharp metallic points of the wick permit the charge to leak away at low electrical pressure.

Corona can be reduced either by using a larger antenna wire or wrapping the wire in polyethylene. Corona on wires, struts, and antenna masts can likewise be prevented by covering them with polyethylene, provided wick dischargers are also used to prevent pressure of the charge from becoming too great. The charge will, however, be generated no matter what is done.

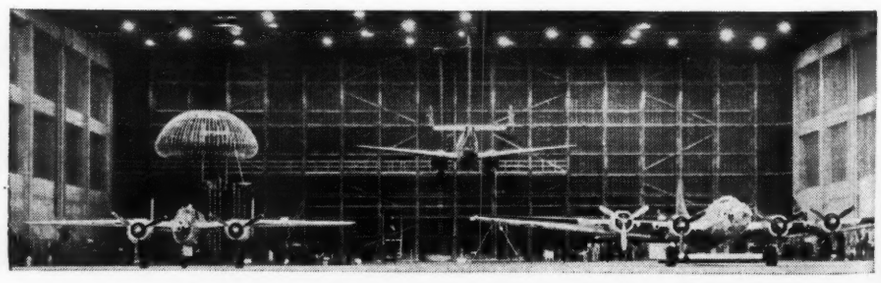
Using the 1,000,000v. generator developed at the University of Minnesota to determine the parts of aircraft at which corona appeared, the project engineers found it formed at all small radius edges, called discharge points, with those near the receiving antenna being particularly objectionable. From their tests, they recommend that, wherever possible, receiving antenna should be located away from sharp edges; antenna should be of large diameter wire; and sharp edges should be avoided. Such design practices will reduce corona, but wick dischargers must still be used to provide low pressure drainage paths for charges that are unavoidably generated on planes.





Oscillograms (above) show how polyethylene insulation on receiving antenna reduces noise. Left top photo shows signal with no noise; right shows how precipitation static obscures test signal; bottom left shows how polyethylene on antenna reduces noise so that test signal can be distinguished.

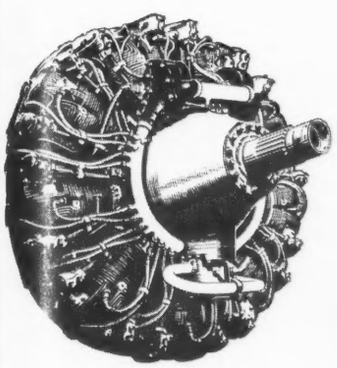
Closeup of wick discharger (left) developed by Army-Navy Atmosphere Electricity Project in cooperation with Northwest Airlines. Comprised of metal ribbon and fiber cord unit, it drains off electric charge at low pressure.



For purposes of measurement, electrical static encountered in flight was duplicated in this hangar-laboratory located at Wold-Chamberlain Field.

Wings of Empire

Britain's inborn aptitude for world trade finds new expression in the operations of British Overseas Airways Corporation. Knitting the Empire and the nations of the world still closer, B.O.A.C. will carry the Union Jack over the familiar shipping lanes on the swift wings of Lockheed Constellations powered by Wright Cyclones.



DIVISION OF
CURTISS WRIGHT
FIRST IN FLIGHT

WRIGHT *Aircraft Engines*

Wright Aeronautical Corporation • Paterson, New Jersey, U.S.A.

Flight after flight and day after day the new Lockheed Constellation is breaking existing records and making aviation history. Keeping pace with it in the air and on the ground is a battery of Timken Roller Bearings.

Installed on rocker arms of the ship's four Wright Cyclone Engines and in the nose wheel, landing wheels, cargo blister and elevator counterbalance mechanism, they assure dependable performance in minimizing friction and carrying the radial, thrust and combined loads imposed upon them under all take-off, flight and landing conditions.

The Timken Roller Bearing Aircraft Series offers a wide variety of sizes in light-weight, maximum-capacity bearings. Make sure the trade-mark "TIMKEN" appears on every bearing you use. Write today. Our engineers will be glad to make specific recommendations for your aircraft and engine problems. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

SIMPLIFYING PERSONAL PLANE DESIGN

PART I

By **RALPH H. UPSON,** *Consulting Engineer*

OUR PREVIOUS SERIES, "Designing Tomorrow's Personal Plane,"* dealt mainly with what might be called the one-way-or-the-other type problem—should the wing be high or low, cantilever or strut braced; should the landing gear be retractable; should the engine be tractor or pusher?

Now we come to those problems of proportioning and degree, demanding not a choice of alternatives, but an optimum point from an infinite series of possible values and combinations.

These are problems having their best approach in a mathematical representation of the governing conditions, tempered by experience and checked by such further experiment as will assure a practical solution. And such experiment must itself be guided by sound "theory"—or else by pot luck—if the result is to be of more than passing interest.

Generally speaking, wind tunnel, structural, or flight tests, important as they are, can only *check* the final answer. They cannot *produce* the answer, except through a test program so extensive as to be outside most budget possibilities. To handle these problems to the best advantage, requires the utmost simplification of design procedure.

A good analogy is the trend toward simplified control—really a case of simplified design. Many and ingenious have been the arguments against it. But despite open questions remaining as to ways and means, the major objects of simplified control now seem to be generally accepted. Will a proposal for simplified design *methods* be the signal to start another long and futile argument?

It seems hardly possible. Yet the superman complex dies hard. As an ardent horseman seeks a spirited, unruly horse to try his skill, and as a professional pilot gets real satisfaction from flying a plane that "has to be flown", so a good engineer welcomes an abstruse or involved problem worthy of his specialized skill—an understandable if not commendable sentiment, but wrong nevertheless.

*June, 1945, through March, 1946, AVIATION.

A New Airplane Is Conceived

The president of an aircraft company calls in his sales manager, production manager, and chief engineer, and says to them: "Our board of directors has decided to put out a new lightplane with maximum appeal to the present market. Its characteristics will be for us to decide." Then, with a hopeful look in the general direction of the sales manager, he asks, "What are your recommendations, gentlemen?"

Not being exactly of a retiring nature, the sales manager, with a side glance at the engineer, speaks up in no uncertain terms: "It must definitely be the safest, cheapest, and best performing plane in its class." And, as something of an afterthought, but still important: "The flight tests should be finished, and we should have our A. T. C. and be ready for production within six months."

"How about it?" asks the president, "Can we do it?" "Sure we can," puts in the confidence-inspiring production manager, "if this guy will just give us the drawings. But they've got to be right—a quarter the usual number of parts, and no expensive gadgets or tooling."

Since it's the very first time that "this guy," the engineer, has heard of the proposition, he has meantime been doing some quick thinking. No room here for any radical change of type; that's out of the picture. So the improvement will have to be wrapped up in the detail design. But that still takes time. Fortunately he has some improvements already on the fire—the kind of fire that perpetually burns in a good engineering office—and he knows his job. His remarks are not too discouraging.

"Well," he begins, "in six months you can have a dressed-up version of our present model; while in nine months you can have some real improvements, with sales points worth talking about—but still just another airplane. Why not put in a few months more and do a *real* job, one that we can be proud of, that will really go to town?"

The final decision, as may be guessed, is to take the dressed-up version, drop the intermediate one, but be working along on the more advanced design. Worse and worse! Instead of one job, difficult enough in itself, the engineer has only succeeded in talking himself into two. He frankly expresses his skepticism as to how much can be accomplished on the advanced design while accelerating to the utmost the model of immediate interest. He leaves the president not quite convinced, however, as to why a little progress takes so much time.

Now let's be honest about it and admit that maybe the boss has something there—that his attitude is at least partly

Ralph Upson's recent series in "Aviation" proved so popular and so valuable to the industry that we joined many engineers in asking him to continue his stimulating discussions on personal plane design. Here he complies, dealing, as he says, with "those problems of proportioning and degree"—which are often among the most perplexing. And, with his usual thoroughness he makes available for creators of personal aircraft what literally amount to new engineering tools—for with each article he will present sound, workable formulas which can be employed in the tough, everyday work of designing new and better airplanes. We will set these formulas up so that they may be most easily and readily used as the efficient tools they are.—The Editors.

justified. Efficiency is a word commonly batted around the engineering department; but before any other kind of efficiency, there must come *engineering* efficiency—which might be defined as the ratio of knowledge-used to knowledge-available.

If some quantitative measure of such efficiency were possible, its fluctuation over the years would be interesting to follow. But even without a quantitative basis, most observers, certainly including the engineers themselves, would probably agree that lightplane design, although improving, still employs only a small fraction of available knowledge, still lags ten years or more behind the possibilities revealed by scientific research. Here we are speaking not of methods or features which, after due consideration, have been dropped for economic or other sufficient cause, but of those which are summarily rejected or missed entirely.

Engineering Department Trouble

There are of course extenuating circumstances—scarcity of time and experienced personnel; problems of standardization and scheduling; the routine labor of computing, drafting, and checking; the inevitable "bugs" in new design; and just ordinary human inertia. The plain truth is that the project engineer, responsible for practical design, is not primarily a scientist, and we cannot expect him to be one. He must use the results of scientific research; but instead of concentrating on a scientific problem, he must coordinate and apply a multitude of often-conflicting results from theory, tests, and practical experience. He must produce numerical calculations and/or new tests of his own to justify the proposed design.

The engineer in charge must not only meet a schedule and a budget in his own department, but often must take the chief burden of responsibility to prove that the plane can be economically produced and operated. And considering that the primary responsibility of the engineer is to make his stuff work, it is certainly no reflection on him that he so often misses features that could be made landmarks of progress. Under the conditions imposed, such as in the case here cited, he must for the most part follow well marked tracks and avoid excursions into unknown territory.

The engineer's problem in general involves dealing with the ever-increasing demands beyond strict engineering requirements. Means of coordinating design with production appear to be rapidly approaching a satisfactory state of affairs. Here there is usually at least a close physical relationship, a chance for direct give and take, and an obvious relation of cause and effect. Not so, the coordination of design and research, where at most only a small part of the pertinent research is directly associated with the design project that has the current priority.

Most of the research-based information, along with its optimum use and associated factors of judgment, must be accumulated through long study, experience, and outside contacts. Keeping up with all the current technical literature can readily be a full-time job in itself, and as these incidental requirements are constantly increasing, it is no wonder the normal design engineering staff is hard-pressed to do more than serve immediate requirements.

It is obvious that one key to a broader engineering coverage is to save time and costs on the routine tasks that make up such a large part of any new design project. Of course the easiest way to do this is to pick conventional numbers more or less out of a hat—power, rpm., and propeller size; wing loading; aspect ratio and the other ratios: taper, thickness, camber; dihedral, twist, sweepback; slots and flaps; fuselage and tail proportions; control and landing-gear characteristics—not to mention all the internal variables of structural importance.

Does anyone seriously expect to get a superior or even acceptable new design that way? "Oh, no," it may be said "we check everything either by calculation or by wind tunnel and structural tests." But an engineering check—like shop inspection, a very necessary function—is at most only insurance that you get what you specify. In other words, if you're asking for "just another airplane," that's what you get.

"Sounds like sense to me—you find the answer on paper, then you check it with wind tunnel tests."

We revert then to the problem of devising more efficient means for handling and properly proportioning the design as a whole. It is here that there is apparently the greatest opportunity for saving time of the real engineering personnel, those who can *use* that saving to the best advantage. For the individual, it means a job instead of a grind, and perhaps the opportunity to follow up that idea he has so long dreamed about, but has had no time to get at.

The Empirical Approach

Any effective, yet sound method of simplifying the design process seems inevitably to mean some kind of empirical representation. Why empirical? In the first place, the average engineer has little time among his many duties to set up conformal transformations and Fourier series, solve differential equations, or perform many other tasks which, for the research scientist, are proper and necessary. Whether to save time in work done personally by the engineer, or to permit such work to be done by relatively untrained personnel, the right kind of empirical simplification pays off in either case.

In the second place, progress would largely come to a stop if we could not consolidate, simplify, and put into practical form each step as we go along. Take, for example, the Glauert method of calculating spanwise lift distribution, or the more straightforward but still too complicated Lotz method; they served their purposes well in reliably establishing, as confirmed by test, a theoretical foundation for solution of this specific problem.

Such solution, however, like others of its kind, is not an end in itself, but must be used as a stepping-stone to other results, such as the optimum coordination of lift, drag, weight, and control characteristics for a given purpose. Unless such calculations can be simplified enough to permit using them as variables on which to base further calculations, their values are sterile at best.

Thus, the term "empirical" is here used as describing not only a means of dealing with observed results for which more rigorous scientific relations are lacking but also as a means of simplifying within a desired range of values, results which by a more exact expression are too complicated for normal engineering use.

Such results, to almost any desired accuracy, can be employed in the form of tables, curves, nomographs, or special computers. But, although no universal rule can be set, it is believed that equations in most cases have advantages of compactness, facility of visualization and checking, definite numerical significance, and adaptability to further opera-

The human side of the engineer's job is a tough one, too.

tions not so well combined in any other form. And they can nearly all be handled by that one essential engineering tool, the slide rule. Believed to be next in order of utility are simple graphical constructions.

Any prejudice against the use of empirical methods is soon overcome when it is realized that, broadly speaking, nearly all modern science is essentially empirical in nature. A good example is the law of gravitation. Copernicus assumed the general nature of motion taken by the planets in their orbits around the sun. The earth could alternatively have been taken as the fixed center, but it was simpler the other way. Tycho Brahe followed with precise observations of the actual relative motions. Kepler, fitting Tycho's observations to the Copernican assumptions, plotted these orbits in more detail, fitted empirical curves to them, and found they all could be closely represented by ellipses with varying coefficients for the path and speed of travel.

Newton, attempting to coordinate the behavior of the planets with that of terrestrial objects, found that these coefficients could be evaluated by the simple assumption that the force between a planet and sun varies directly as the product of the masses and inversely as the square of the distance between them. Although even Einstein's later and still broader generalization can be considered empirical in the sense that it was chosen to fit observed facts and rational assumptions, it brings out more definitely the essentially empirical nature of Newton's law and its virtual necessity in dealing with the great mass of calculations for which, with few exceptions, it is perfectly valid.

Getting Formula-Conscious

To a practical engineer, mathematics is technical shorthand, in accordance with which a simple equation or formula may well be regarded as its supreme achievement. A good formula, by presenting a known group of facts, sets up a problem, shows a picture, points the way, and indicates the solution. Yet, followed blindly out of its proper domain, misunderstood, or otherwise misused, it well merits the disrepute into which it may fall. True, there *is* such a thing as being a slave to formulas; but he who understands them, sees the pictures that they paint and their handwriting on the wall, is *not* their slave but their master. And the more he can get to serve him the better.

So, quite opposite to the one-time boast of "flight without formulas," let us have more and better formulas (although preferably not bigger ones!). These should be in explicit algebraic form where possible, but trigonometric, logarithmic, and other readily usuable functions, are of course acceptable. Decimal exponents are usually simpler than trying to avoid them, and are no trouble on a log-log rule. Derivatives and integrals, if used, should be based on simple explicit equations, and integrations of any great difficulty should be confined to graphical solutions.

All this, of course, applies to routine engineering operations, not to exploratory or research activities usually calling for a specialist outside the regular engineering staff. ***But such research should not be considered complete till its results can be put to use in practical engineering form.***

The means employed to accomplish this purpose will vary widely for different conditions, as illustrated by the following:

1. A few simple fundamental relations can be left unchanged. Elementary examples: Area of a circle; accelerating force.

2. Often a binomial occurs in the form $y = (1+x)^n$ where x is a small fraction, in which case $y \approx 1 + nx$. Example: Solution of the quadratic $ax^2 + bx + c = 0$;

$$x = \frac{1}{2a}(-b \pm \sqrt{b^2 - 4ac}) \approx$$

$$\frac{b}{2a}\left(-1 \pm 1 \mp \frac{2ac}{b^2}\right) \text{ for } 4ac/b^2 = \text{small.}$$

3. A multiplicity of different variables can almost always be combined to form a smaller number. Example:

$ax^3 + bx = C$ which can be put into the form

$$\left(\frac{a}{b}\right)^{1/2} x^3 + \left(\frac{a}{b}\right)^{1/2} x = \frac{a^{1/2}}{b^{3/2}} C$$

$$\text{or } x_1^3 + x_1 = C_1$$

4. An implicit function, such as x_1 above, can be made explicit by plotting (or tabulating) the curve and fitting an

empirical equation to the portion covering the usable range. A family of curves with more variables can be similarly treated. (Even when a direct soultion is possible, such as for the above cubic equation, the result is usually too complicated for practical use). Example: Solution of the basic performance equation for speed.

5. A gradual curve of theoretical or experimental points can be approximated by a straight secant line cutting across two points of the curve, in a position to average the error within the desired useful range. This method is generally superior to the more commonly used tangent line, exact only at one point and usually throwing the error all in one direction. Example: Approximation of maximum speed when induced drag is relatively small.

6. More extended or sharply curved functions can be similarly approximated by a parabolic or other simple curve. Example: Variable profile-parasite drag as a parabolic function of lift coefficient.

7. A function in several terms, each in the form $Kx^m y^n z^p \ldots$, where K, m, n, p, etc., all have differing values in the various terms, can be approximated in fewer terms of the same form for any desired limited range of values. Example: Wing weight as a summation of terms for surface, beam flanges, webs, ribs, etc.

8. Various methods of interpolation and extrapolation can be employed. Although extrapolation is usually looked upon with disfavor, it can often be used to a moderate extent, provided there is no change of condition within the desired range. Example: Taylor's series is essentially a means of extrapolation from the characteristics at a single point, valid within the circle of convergence.

9. Trial and error, guided by experience in the recognition and fitting of special curves, is invaluable for cases where a fairly complete range of values must be covered. Example: Variation of beam-flange weight with taper characteristics.

Although much remains to be done in thus putting into practical form the results of previous research, it is felt that a good start has been made. In this and succeeding articles the symbols will be listed, the formulas classified, and references given, where available, for the basic theory as well as for equations recommended. Many of the latter are presented for the first time. The order of accuracy will be given within specified limits of the dependent variables. "Accurate" here has its usual engineering meaning—i.e., "Within slide-rule accuracy." Explanation of the more important formulas and examples of their use will be found in the text.

To avoid transposition, all formulas are expressed directly in the customary units of lb., slugs, hp., deg. F., air pressures in lb./sq. ft., stresses in lb./sq. in.; distance in mi., altitude in ft., general dimensions in ft., moments in lb.-ft., angles in deg., horizontal speed in mph., climb in fpm., and rotational speed in rpm. It is too bad we have never gotten into step with most of the world by adopting the metric system; but as long as we haven't, our own standards are followed all the way, the only liberties taken being that a few of the symbols, like altitude and engine speed, are in thousands of units to permit dealing with smaller numbers.

As there is room in this article for only a few elementary formulas, what better start can be made than with equations for the atmosphere itself, on which all aircraft design depends?

Except in the special cases noted, these formulas cover the entire troposphere (up to about 35,000 ft.), although it is hardly conceivable that the personal flyer would be interested in more than about 12,000 ft., unless for something like crossing the Andes. As will be brought out later in our series, however, it is believed that private pilots often miss good chances for improving their speed, fuel economy, and personal comfort by staying at too-low altitudes.

The aeronautical standard atmosphere is of course itself an empirical approximation, based on a somewhat arbitrary sea level pressure and the assumption of a constant temperature gradient or lapse rate in the troposphere.[1] It starts with a sea level temperature of 59 deg. F. which is different, incidentally, from the physical standard of 0 deg. C.

Although the design engineer deals ordinarily with the standard atmosphere alone, the product of his work must be tested in an actual atmosphere where density, pressure, and temperature no longer have the unique relationship to each other and to the actual altitude assumed in the standard atmosphere. A properly adjusted altimeter gives the "pressure altitude" H_p, the altitude in the standard atmosphere corresponding to the static pressure.

But, with the exception of engine power, the designer of low-speed aircraft is more directly interested in air density, hence the analogous term "density altitude" H_σ. For the higher speeds, a good case can be made for a "temperature altitude." What it amounts to is

"I'll settle for this."

[1] See comparison with typical average conditions in Ref. 1.

that all three characteristics must be considered in relation to different effects.

The relations between σ, p/p_0, and H in the standard atmosphere as given by Equations 1 and 2 can, of course, be taken alternatively from a table or chart. Still easier for the engineer is to think and deal primarily in terms of the relative density σ, which can be used directly in most computations. Choice of a standard cruising altitude, such as for $\sigma = .811$ (7,000 ft.), then permits, for most purposes, reduction of the "table" to values for sea level and this one other altitude, with formulas for *MN*, *RN*, power factors, and other related functions appearing on the same sheet, all in a form for quick use, with fractional powers of σ worked out in advance.

For the usual moderate altitudes, Equation 3 gives a close approximation especially convenient for a pilot. All he does is divide the density altitude in thousands of feet by 0.6 and add it as a percentage to the calibrated airspeed reading to get the true airspeed.

Incidentally, the present accepted usage of "indicated airspeed" makes it something of a misnomer. As the very name implies, it originally meant the speed indicated by the instrument, but now it is customarily defined solely and specifically by the analytical expression here given. However, an airspeed indicator adjusted, positioned, or calibrated to give all speeds correctly for $\sigma = 1.0$ will continue to give $v\sqrt{\sigma}$ within 1% for all atmospheric variations up to 20,000 ft. "temperature altitude," and 200 mph. indicated speed (Ref. 3).

The Reynolds and Mach numbers, Equations 4 and 5, are from well known elementary theory, yet in most sources of information on these relations there is apparently no attempt to present them in really convenient form. No more accurate form for *RN* is needed than the one Equation 4. It may possibly be questioned why Mach numbers are introduced at all in a discussion of personal plane design. The answer to this one must come later, in connection with propellers and some of the recent wing developments.

In similar manner to the indicated speed, the reference pressure q, Equation 10, is simply a matter of arbitrary definition—for use as a convenient common factor in the various aerodynamic coefficients. Otherwise the equations here listed for the actual atmosphere will seldom be of real importance in lightplane design, but they are included for reference in simple form.

So there you are—A barefaced espousal of intellectual economy! At any moment we may expect to hear the chorus of protest. Indeed it has already begun. It began at least as far back as Newton's analytical methods. The words are lost, but the argument can be readily imagined: "Formulas and short cuts! That's no respectable way to solve problems. We should get back to Pythagorus and Euclid." And somewhat more recently: "Who wants to be a handbook engineer?" Well I, for one, do—if by such means we can progress still further, accomplish a little more, and make room for more of the true fundamental: sound, resourceful thinking in the approach to the many *new* problems still ahead in aircraft development.

In his next article, Mr. Upson will discuss the all-important subject of performance.

THIS MONTH'S FORMULAS

Standard Atmosphere

(1) $\sigma = (1 - H/145.4)^{4.26} = (p/p_0)^{.81}$ — Ref. 1

(2) $H = 145.4\,(1 - \sigma^{.235}) = 7$ for $\sigma = .811$ (7,000 ft.)
(1) and (2) accurate for $H < 35.$ and $\sigma > 0.31$ } 35,000 ft.

(3) $v/v_i = 1/\sqrt{\sigma} = 1 + H/60$ — Ref. 2
within 1% for $H < 15$

(4) $RN = 9350\,c\,v\,\sigma^{.81} = 7{,}900\,c\,v$ for $\sigma = .811$ (7,000 ft.)
within 0.3% for $\sigma > 0.31$ — Based on Ref. 1

(5) $MN = \dfrac{v}{762\,\sigma^{.118}} = v/745$ for $\sigma = .811$ (7,000 ft.)
Accurate for $\sigma > 0.31$

Actual Atmosphere

(6) $p/p_0 = (1 - H_p/145.4)^{5.26}$ — Ref. 1

(7) $H_p = 145.4\,[1 - (p/p_0)^{.19}]$ — Ref. 1

(8) $H_\sigma = 145.4 - (1.35/T^{.235})\,(145.4 - H_p)^{1.235}$

(9) $\sigma = (519/T)\,(1 - H_p/145.4)^{5.26}$
(6), (7), (8) and (9) accurate for $H_p < 35$ and $\sigma > 0.31$

(10) $q = \sigma\,v^2/391 = v_i{}^2/391$
accurate by definition, for all conditions.

(11) $MN = \dfrac{v}{33.5\sqrt{T}}$ — Ref. 1
accurate for all conditions

(12) $p_p - p = q\,(1 + .26\,MN^2)$ — Based on Ref. 1
within 1% for $MN < 0.9$

Symbols

σ = ρ/ρ_0 = air density relative to standard at sea level
$\rho_0 = .00238$ slugs/ft.^{3}
T = absolute air temperature = 460 + deg. F.
p = static pressure
p_0 = static pressure at sea level in standard atmosphere = 2,116 lb./ft.^{2}
p_p = pitot pressure; $p_p - p$ = measured dynamic pressure
q = dynamic pressure for low Mach number (lb./ft.^{2}) defined by Eq. 8
v = true airspeed (mph.)
v_i = indicated airspeed = $19.8\sqrt{q} = v\sqrt{\sigma}$
H = altitude above sea level (thousands of ft.)
H_p = same, according to Eq. 7 (pressure altitude—fictitious)
H_σ = same, according to Eq. 8 (density altitude—fictitious)
Note: In standard atmosphere $H_p = H_\sigma = H$
c = wing chord (ft.) (or other designated dimension parallel to airflow)
RN = Reynolds number, Eq. 4
MN = Mach number Eq. 5 and 11

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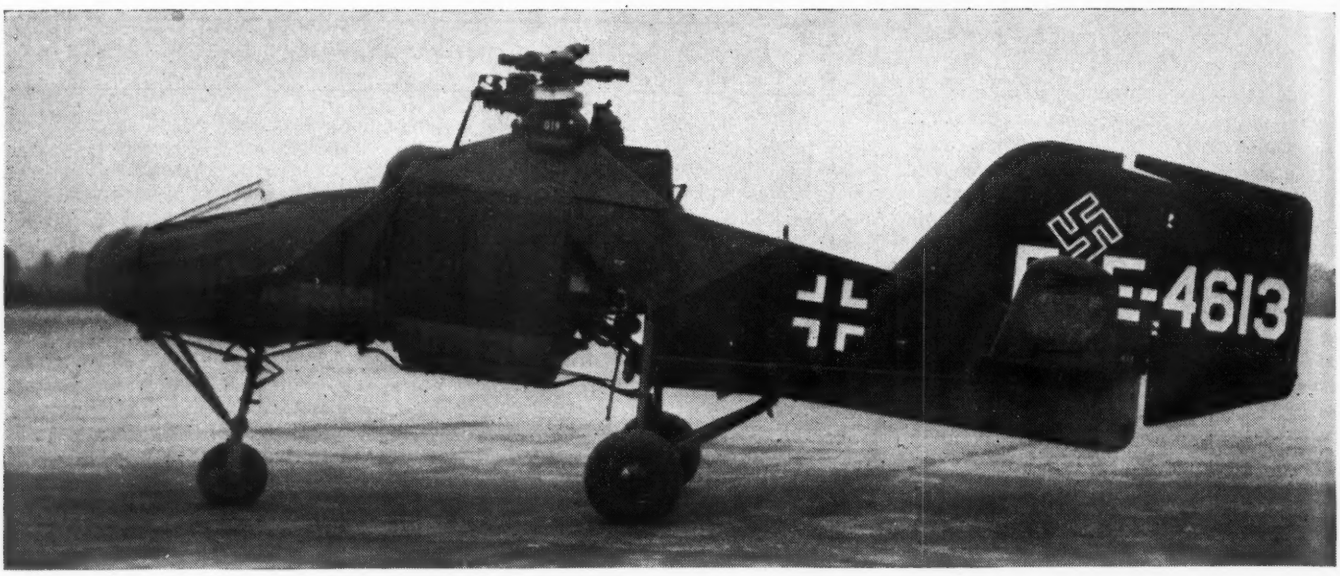
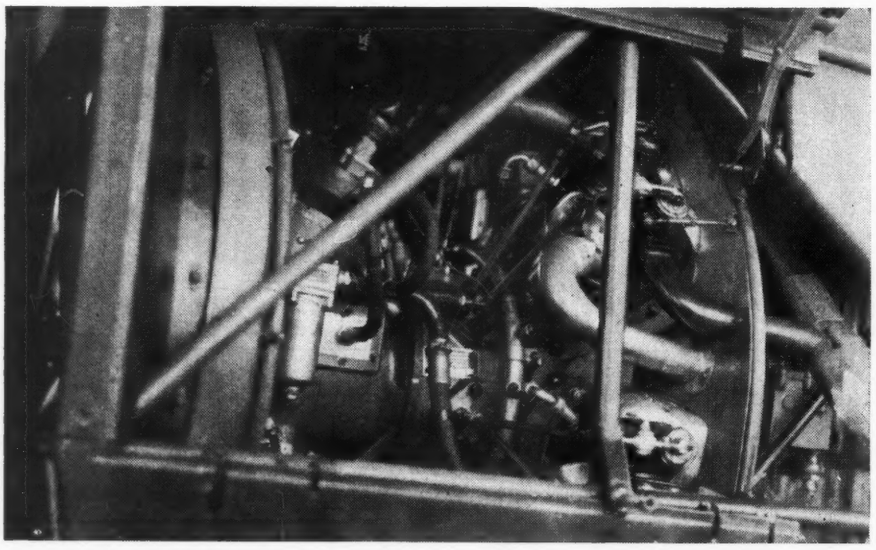
1. Richard von Mises, *Theory of Flight*, McGraw-Hill Book Co., New York City, 1945.
2. Walter Diehl, *Engineering Aerodynamics*, Ronald Press, New York City, 1936.
3. Wm. C. Schoolfield, *A Simple Method of Applying the Compressibility Correction*; Journal of the Aeronautical Sciences, Oct. 1942.



Seen here is development model of Flettner Fl-282 helicopter (minus rotors) now being tested in this country. Engine compartment is accessible via hinged side panels. Tail surfaces of this craft appear to have different characteristics from those of Fl-282B (see opposite page).

Design and Flight Characteristics Of the Flettner Fl-282 Helicopter

Presented here is a clear analysis of Germany's foremost rotocraft development—the Flettner Fl-282. And included in this first, well-rounded study is sufficient detail to enable comparison of its engineering with that of our own 'copter types.



Close-up of engine installation with access panel lifted. Housing for fan is seen at left, while mounted at angle on top of crankcase is lower transmission.

MOST ADVANCED of German rotary wing projects, and a craft which has flown more hours than any other Nazi 'copter, the Flettner Fl-282 Kolibri has aroused great interest both here and abroad, despite the fact that little detailed information has been heretofore available.

Extremely maneuverable, according to a U. S. TIIC report by Bartram Kelley and Hugh J. Mulvey, this two-place craft with intermeshing two-bladed twin-rotors and substantial tail surfaces has been flown in very bad weather, rain, and gusty air, also has been piloted blind. Many tests were conducted—for autorotation, altitude, speed, stability, vibration, and vibratory stresses—and hundreds of power-off landings were made. In an endurance test, one ship was flown 95 hr. without repairs or changes. Permissible C.G. travel allows flight with and without passenger without changing trim, although this procedure increases vibration.

At 2,200 lb. gross weight, vertical climb at sea level is given as 300 fpm. Maximum speed in level flight is 90 mph., and hovering ceiling is roughly estimated to be 1,000 ft. With disk loading of 1.8 lb./sq. ft., the vertical autorotative descent is given as 26 ft./

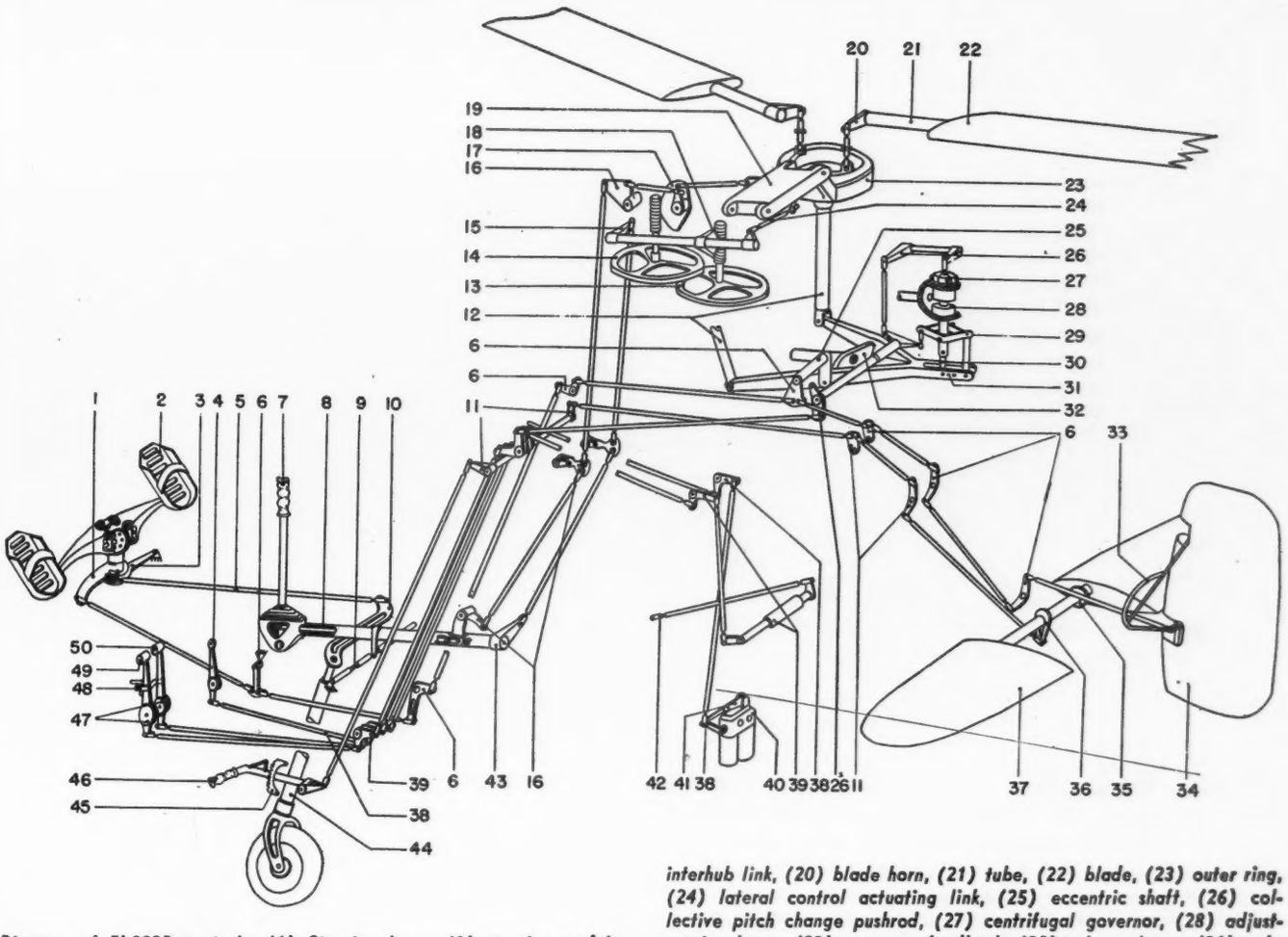


Diagram of Fl-282B controls; (1) Steering lever, (2) steering pedal, (3) friction damper, (4) fuel cock lever, (5) nose wheel steering push-rod, (6) rudder bellcrank, (7) stick, (8) control shaft, (9) lateral control neutral point, (10) nose wheel steering lever, (11) elevator trim bellcranks, (12) directional control actuating rod, (13) lateral control inertia ring, (14) longitudinal control inertia ring, (15) lateral control link, (16) longitudinal control linkage, (17) sector engaging worm, (18) lateral control segment and worm, (19) lateral control interhub link, (20) blade horn, (21) tube, (22) blade, (23) outer ring, (24) lateral control actuating link, (25) eccentric shaft, (26) collective pitch change pushrod, (27) centrifugal governor, (28) adjustment release, (29) governor feedback, (30) release lever, (31) yoke lever, (32) lateral control yoke, (33) C. G. trim, (34) rudder, (35) friction damper, (36) elevator bellcrank, (37) elevator, (38) fuel cock pushrod, (39) throttle bellcranks, (40) fuel filter, (41) hand-pump lever, (42) quick-acting carburetor cutoff lever, (43) lateral control crank, (44) nose wheel strut, (45) elevator trim lever ratchet sector, (46) elevator trim lever, (47) adjustable dampers, (48) setting mechanism, (49) collective pitch lever, and (50) throttle lever.

sec., although apparently no systematic tests were made at very low speeds to show rate of descent as a function of speed. Maximum speed of sidewise flight is about 15 mph., and maximum diving speed is about 109 mph.

Stability

The craft is stated to be neutrally stable in hovering. If the stick is given an arbitrary displacement, and then held fixed in central position, the craft will execute a swinging motion, amplitude of which neither increases nor decreases. In forward flight, there is a longitudinal instability, reaching a maximum at about 25 mph., and at speeds greater than 37 mph. flight is again stable. Period of phugoid instability is about 11 sec. when stick is held fixed. In forward flight above 37 mph., the craft can be flown hands-off for an indefinite period by adjusting a bungee in the cockpit to neutralize stick load.

An interesting feature of the phugoid oscillation is that if the stick is suddenly displaced forward, then returned, motion is stable, whereas if the disturbance is caused by a sudden rearward displacement, motion is unstable.

The craft is stable in yaw. Approximately two oscillations per minute have been observed, but amplitude does not increase.

Vibration

The Flettner 'copter is considered rough. The two-bladed rotors (synchronized to be parallel in the 45-deg. positions) produce fuselage vibrations which appear to be torsional about the vertical axis. Blades are provided with flapping and drag hinges, the latter damped by adjustable metal-to-metal friction. There are no other means of isolating aerodynamic forces from pilot. During rev-up, the craft shakes rather badly on its landing gear (the vibration being sensitive to tire pressure) but sweetens up before takeoff. In flight, control stick vibrations were at first severe, but were greatly reduced by the well-known means of adding inertia to the system. Movement of either cyclic-pitch pushrod drives a sector, engaging a worm to which a small flywheel is attached. Although this device substantially cured control stick vibration, it involves disadvantages of having a sluggish stick and tendency to overshoot a given displacement. Mr. Flettner has emphasized that when the drag hinge friction dampers are very carefully adjusted, vibrations of the craft are much reduced. (Recommended setting is slippage at 94 lb.-ft. applied torque.)

Dr. Kurt Hohenemser (theoretical expert from Göttingen, who performed extensive calculations of stability, vibrations, and performance) has shown by analysis that a self-excited oscillation could occur in flight at low rpm. and

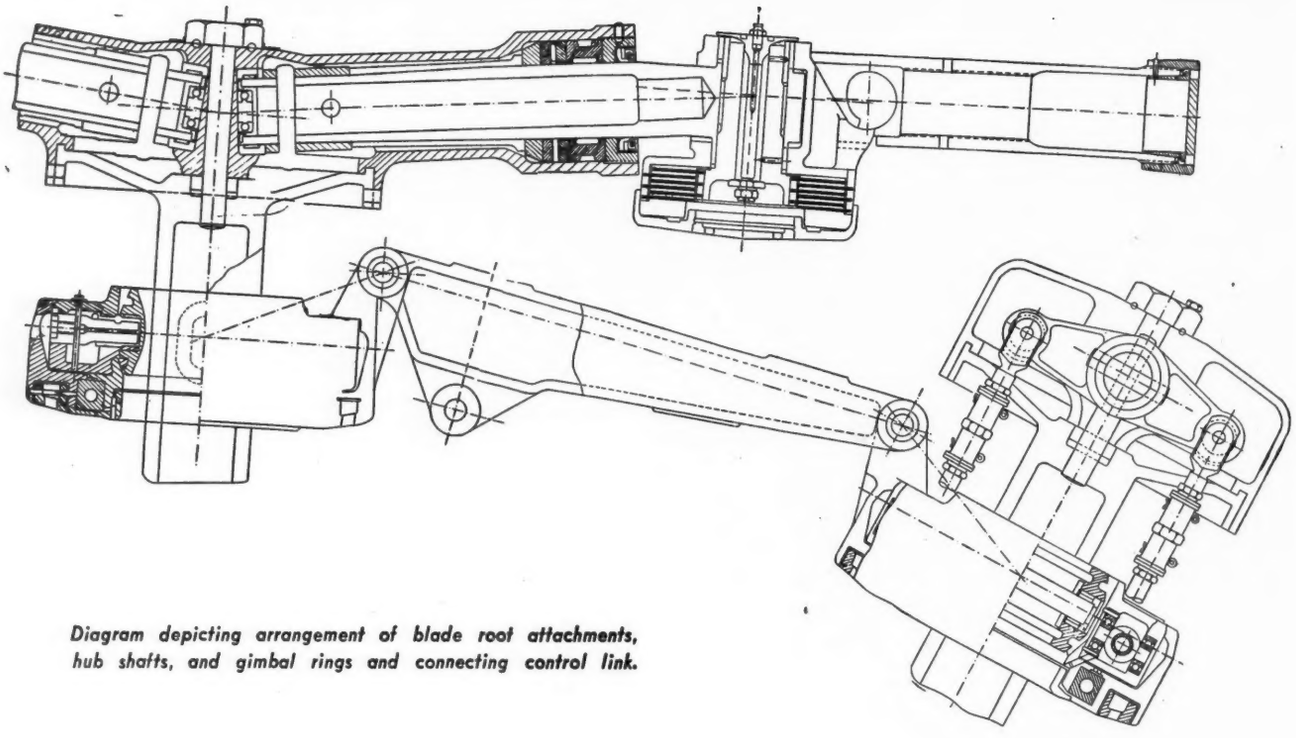


Diagram depicting arrangement of blade root attachments, hub shafts, and gimbal rings and connecting control link.

high pitch. This oscillation was experienced severely on one occasion at 140 rotor rpm., but disappeared when the craft was put into autorotation and rpm. increased.

Vibratory stresses at critical points were measured by strain-gage technique and were found to be excessive in the control links at maximum speed. As a result, diving at high speed was prohibited.

Detail Design

Rotor blades. These are of conventional construction, embodying 1.5-in. o.d. .138-in. steel tubular spar, wood ribs attached to steel collars, plywood cover, and fabric over the plywood. Blades are straight, have 19.65-ft. radius, and 11.42-in. chord. The .039-in. plywood cover is wrapped over the leading edge, which is .63 in. wide. Trailing edge is laminated vertically and has total width of 1.34 in. from ribs 1 to 16, and .98 in. outboard of rib 16. Rib components have built-up construction of two capstrips with plywood webs on either side, and are uniformly spaced at 3.9 in. along entire blade. A solid block is added between capstrips at the spar for riveting rib collars.

Blade has twist of 4 deg., the angle of incidence decreasing from inboard to tip. Turned-up tab, 17 in. long and extending .79 in. to rear of trailing edge, is installed just inboard of the tip. The tab is fixed but can presumably be bent to change blade moment coefficient.

Blade section appears to be of NACA 23000 series with 17% max. thickness.

Originally, blades were built with chordwise balance weights only on outer half. This was found to be unsatisfactory, hence similar weights were added on the blade inner half. Weights are attached to leading edge aft side with screws. Total weight of the blade is 88 lb.

Lacquer is used on the fabric cover to obtain a very smooth uniform surface, and thus maintain blade balance. Protracted flights are claimed possible in rain or snow, without damage to leading edge.

Spar is threaded on inboard end for attachment to a sleeve having a forked end forming part of the horizontal hinge. The sleeve telescopes over the spar for approximately 6.3 in., so that the spar threaded section is some distance from point of maximum moment on the spar. A pin through sleeve and spar prevents relative rotation.

Rotor hub and transmission. The twin two-bladed rotors are mounted on shafts having an included angle of 24 deg. and spaced 23.2 in. apart at the intersection of the planes of the horizontal pins and centerlines of rotation. Horizontal and vertical blade-hinges are coincident and located at 12.8 in. outboard of centerline of rotation. Location of the horizontal hinges so far outboard permits hubs to be brought closer together, gives better blade clearance, and affords added advantage of producing greater control moment for given flapping. Disadvantage is greater roughness with divergence of tip path plane from the plane normal to mechanical axis. This divergence varies with forward speed and C.G. position. Hence, it is possible to have considerable roughness in hovering if C.G. is such that tip path plane is not perpendicular to axis.

Bearings for pitch axis of blade are located inboard of horizontal and vertical hinges, and the axis is inclined up at an angle of 6 deg. to centerline of rotation. Since the control is located inboard of hinges, it is not affected by movement of blade about hinges. Vertical hinge is parallel to centerline of rotation, hence is 6 deg. from normal to pitch axis.

Vertical and horizontal hinges, as well as pitch change axis, have needle bearings. Thrust bearing for pitch change axis is also a needle bearing. Load on the bearings of the hinges is about 5,000 psi., based on nominal projected bearing area. No trouble was experienced with these bearings under this loading.

Blade dampers mounted on the vertical hinge are friction type with multiple steel and brass plates. Load is applied through a rubber disk, pressure being adjusted by turning the damper cap. Usual setting of damper gives a torque of 94 lb.-ft.

Centrifugally operated droop stops installed on blades allow rev-up at a coning angle of plus 1 deg. and still permit the blades to flap down to an angle of minus 5 deg. in flight. The stop is a cam moved by a hinged weight, which flies out because of centrifugal force. At 110-120 rpm., the cam moves and allows the blade to fall to an angle of minus 5 deg. To set the stop for a coning angle of plus 1 deg., the blade

must be raised by hand until a spring moves the cam into proper position—this being automatically accomplished if the collective pitch setting is sufficiently large as the rotor slows down.

Upper transmission, providing the mounting for the two hub shafts, is supported on a steel tubular structure, similar to an engine mount, attached to the fuselage at upper longerons.

The two hub shafts, mounted in roller bearings, with an additional ball bearing to take thrust, are geared to a short cross-shaft upon which is mounted another gear meshing with a central pinion shaft. Design of the cross-shaft is somewhat unusual and, while heavy, the unit should give very rigid mounting for the pinion on either end. To decrease the diameter of the bearings for mounting this shaft, the latter is used as the inner race.

On the central pinion shaft is mounted the freewheeling unit, which disconnects the engine and upper transmission. A rotor brake installation is also mounted on the shaft.

Upper and lower transmission units are connected through a short drive shaft having a universal joint at each end. Lower transmission is mounted on forward end of engine crankcase, and pinion of this unit is mounted on the crankshaft, using usual propeller splines and cones. This transmission changes the direction of drive (upward and aft 65 deg.) to line up with upper transmission. On the nearly vertical shaft is mounted a multiple-disk clutch and a dog-type coupling. To rev-up rotor, friction clutch is engaged by moving a lever in cockpit. When engine and rotor tachometers indicate that there is no slippage of the clutch, the dog-type coupling is engaged by further movement of clutch lever. Because propeller shaft was not long enough, an extension was added to allow for mounting the fan forward of the transmission.

With three sets of gears, the two transmission units effect a total reduction of 12.2 to 1 between engine and rotors. When the engine turns at 2,200 rpm., rotor turns at 180. All gears are spiral bevel. Considerable use of roller bearings is made, ball bearings being used only where thrust or combined thrust-and-radial loads require them. Since transmission cases are made of magnesium, heavy steel sleeves are inserted wherever bearings are located.

Controls. Joint cyclic pitch change of the two rotors (tilting both gimbal rings in the same direction) accomplishes longitudinal and lateral control.

Steering control is obtained by a combination of rudder and differential collective pitch change on the two rotors. The large rudder is necessary to give sufficient directional control during autorotation, since the differential collective pitch is ineffective in this condition. It is claimed that in power operation, sufficient control in yaw is available to accomplish all maneuvers, even when hovering in winds of 20 mph. Some trouble has been experienced by new pilots when operating very low, because as they come around into the wind they lose lift and strike the ground.

Adjustable stabilizer is provided, but a setting of plus 4 deg. has been found to be satisfactory for all forward speeds.

Collective pitch control is located adjacent to throttle so that both may be moved simultaneously, if desired. This pitch lever does not actuate the collective pitch directly but operates it through a blade-pitch governor.

Blade-pitch governor holds rotor rpm. within certain limits. Mechanism controlling pitch consists of springs acting against levers moved by centrifugal force, the springs tending to decrease pitch and the levers tending to increase it. Initial spring load can be adjusted on the ground to govern at any desired rpm., also minimum angle can be set, below which the governor cannot further reduce pitch. This latter setting is chosen to give positive autorotational characteristics in event of power failure.

In early tests of the craft, the governor was set for a minimum of 140 rpm., and in one instance of power-off flight, autorotation actually stopped, the craft dropping to hit the ground very hard. On another occasion, self-excited vibrations were encountered in flight. After these episodes, the governor was set for a minimum of 160 rpm.

Collective pitch lever allows pilot to override the governor and adjust pitch. It has been stated that pilot can override governor only to increase rpm., but cannot reduce the rpm. below that of the governor setting.

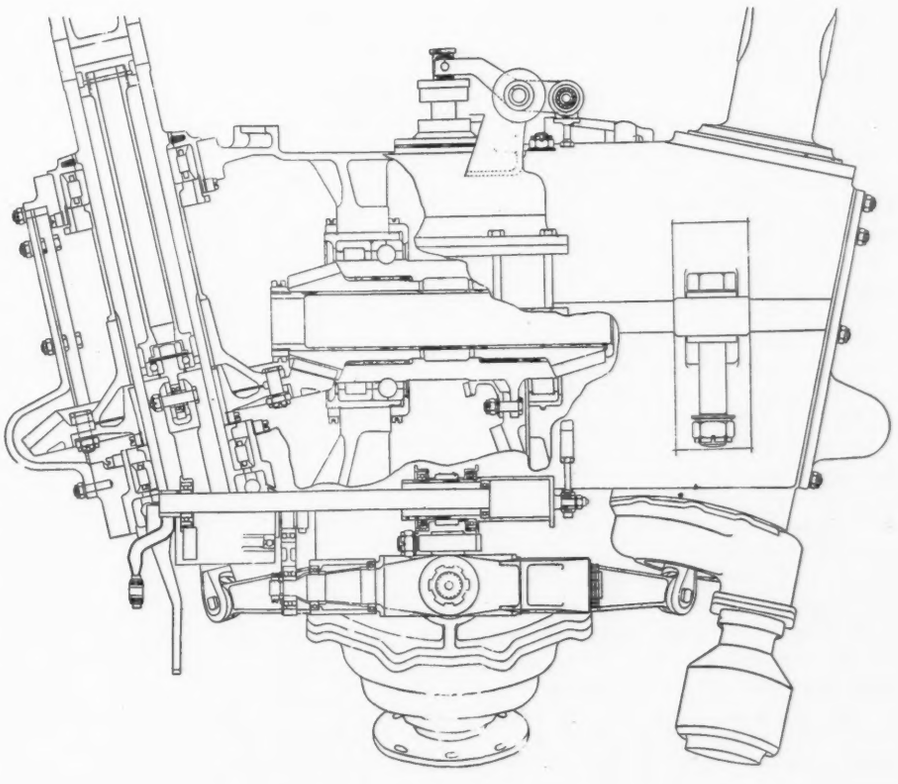
Governor is power-operated through two oppositely rotating clutches driven from upper transmission.

Specific values of pitch angles used in the controls, are:

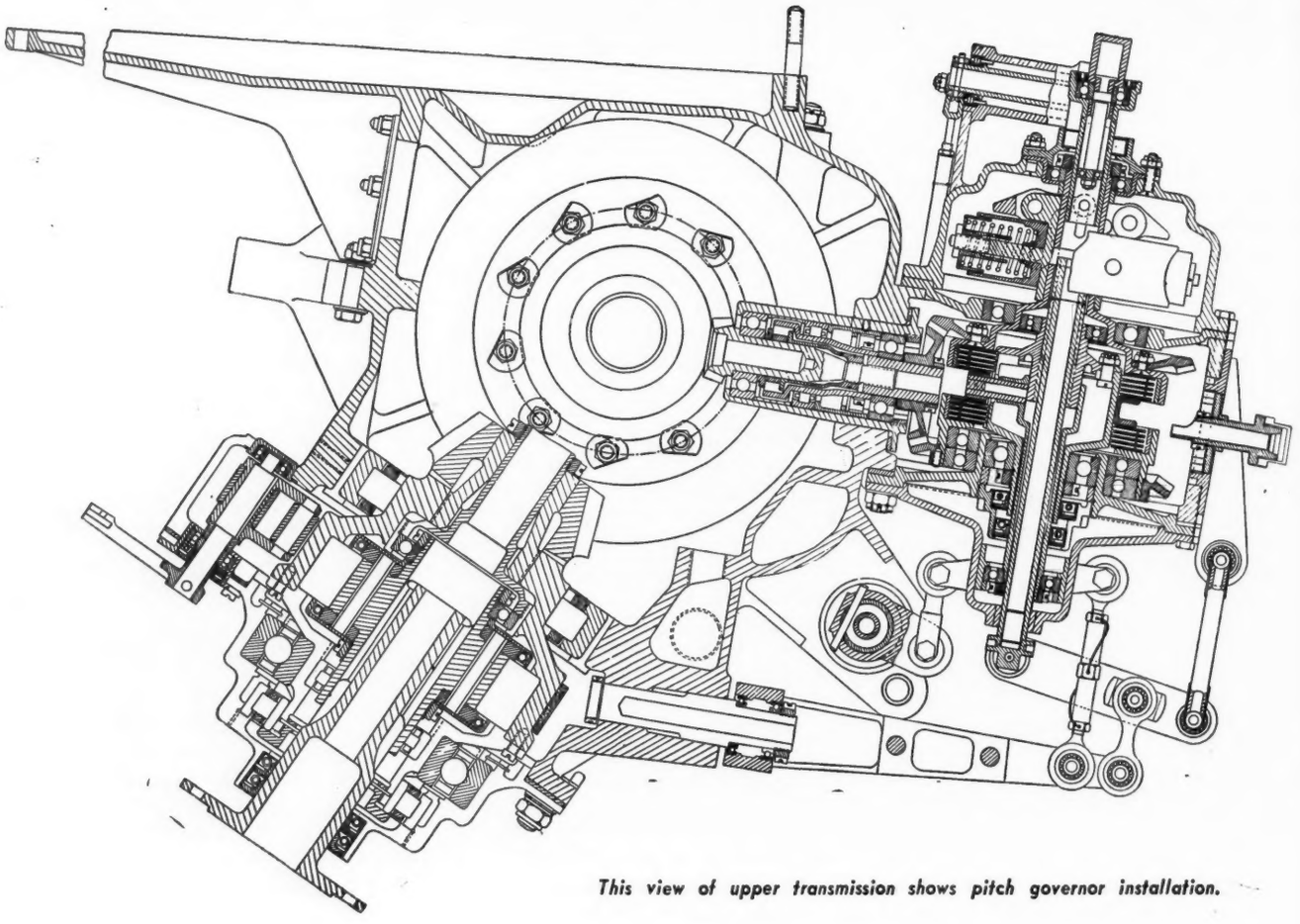
Maximum collective pitch	8 deg.
Collective pitch required for hovering	6.5 deg.
Cyclic pitch, forward feathering	8 deg.
aft feathering	4 deg.
lateral feathering	3.6 deg.

Engine installation. Power plant is Siemens Halske 7-cyl. radial, aircooled installation mounted with crankshaft horizontal. Rating is 140 hp. at 2,200 rpm. for sea level takeoff, and cruising rpm. is 2,050. Engine overhaul period is reported as 400 hr.

An eight-bladed 26.8-in. dia. wooden fan is mounted on an extension to the propeller shaft. Air enters at fuselage bottom, passes through fan to engine,



Details of upper transmission connecting two hubs and of collective pitch linkage to hubs.



This view of upper transmission shows pitch governor installation.

and down and out through another opening in fuselage bottom. No means of controlling air flow is provided. Normal engine temperature is 225 deg. C. (437 deg. F.).

Fuel capacity is 105 l. (27.8 gal.) in two tanks, but with two people, fuel load is limited to 65 l. (17.2 gal.).

An oil sump, located under engine nose section, holds approximately 2 gal. of oil, and also serves as a tank. A filter cleans the oil every 2 hr. Oil consumption is approximately 1 qt./hr.

Two carburetors are used, opening into the same manifold. No mixture control or means for preheating air is provided.

The engine is started by utilizing a high pressure air tank connected to the cylinders through a distributor, and with ignition "on," fuel is pumped into the intake manifold. Air pressure of 200 psi. is sufficient for warm weather and 400 for cold.

Conventional steel tubular engine mount is bolted directly to intake manifold, with no vibration absorber.

Landing gear. Gear is of the tricycle type, with spring-oil shock struts. On the main gear, the shock strut is inclined inward at an angle of 35-40 deg. from vertical and is subject to bending because of wheel offset. Total strut travel is 2.36 in. and the vertical wheel travel is 4.33 in. Tires are 18.32 by 6.50. Tread is 81.5 in. with shock strut extended and 84.3 in. compressed. Nose wheel strut travel is 6.30 in. and vertical wheel travel is 4.92 in. Tire is 13.80 by 5.12. Nose wheel is steerable, being connected to rudder pedals.

The craft has been landed from vertical descents in the manner characteristic of autogiros (by pulling back on control stick after nosing down from vertical descent), collective pitch not being used. In one such landing the tail was damaged by hitting the ground. Dr. Hohenemser recommends that a ground angle of approximately 20 deg. between wheels and tail is desirable for this type of landing.

Body. Fuselage construction features welded steel tubes. Center section enclosing engine is metal-covered and rear section is fabric-covered. Body shape is not aerodynamically desirable, since tuft tests have indicated that flow separation (or turbulence) is so great that it makes much of the tail surface ineffective.

Although only 22 craft were actually constructed, plans were under way for production of 1,000 units as the European war ended. General quality of design and workmanship is excellent, although drive mechanisms, pitch-actuating governor, and controls are, in many instances, unnecessarily heavy and complicated. The combination of 140 hp., 1,400 lb. empty weight, and 2,200 lb. gross weight (with good performance), indicates what can be accomplished with this configuration, using a 39.3-ft. dia. rotor. Compared with the tail-rotor type craft, it has been found that only slightly less hp. and engine weight are required, but a greater weight of rotors and drives, droop stop mechanisms, controls, and other installations are necessary.

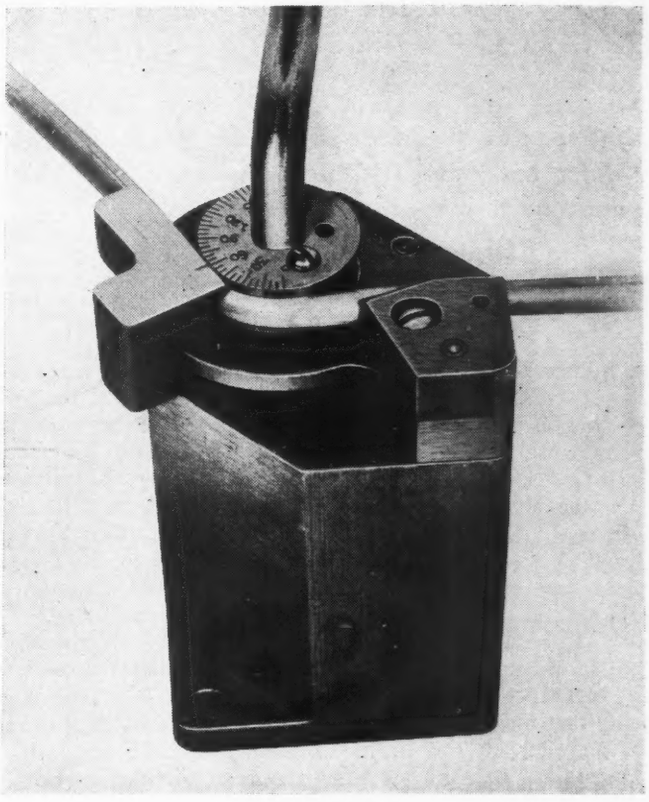
General Data

Empty weight	1,410 lb
Gross weight	2,205 lb.
Rotor diameter (each)	39.3 ft.
Engine	7 cyl. radial aircooled Siemens Halske
Engine takeoff rating, S. L.	140 metric hp.
Fuel, one person	27.8 gal.
Fuel, two persons	17.2 gal.

Rotor Characteristics

Total incl. angle between axis	24 deg.
Blades per rotor	2
Blade chord	11.42 in.
Disk area	1,212 sq. ft.
Disk loading at 2,205 lb.	1.82 lb./sq. ft.
Solidity	.06
Forward feathering	8 deg.
Lateral feathering	3.6 deg.
Aft feathering	4 deg.
Rotor turns, best cruising	175 rpm.
Rotor turns, takeoff	180 rpm. (engine, 2,200 rpm.)

PLANT PRACTICE HIGHLIGHTS



Manual Bending Tool Gives Improved Accuracy

• Designed to enable bench workers to bend tubing with greater accuracy than had formerly been possible, this simple device may also be used for working heavy electrical cable, such as is installed for battery leads.

Tool consists of a heavy base, fitted with a graduated center, around which material is bent. At right is a stationary block, so placed that stock to be bent is tangential to center piece at the zero-degree mark. Pivoted on lower part of center is movable block (left) which is rotated around center piece until required bend has been obtained in tubing. On top surface of movable block, a mark is placed to indicate point of tangency of tubing being worked upon.

Designed by Carroll E. Andreon, employee of Glenn L. Martin Baltimore plant, tool has these three advantages over old bending methods: Greater accuracy than that usually specified can be obtained, time formerly lost in measuring angle of bend is saved, and material is no longer wasted through being flattened or split during bending operation.

Time and Labor Saved by Gusset Clamps

• This tool, made from two U-shaped steel plates, is adjustably bolted together and fitted with a locating arm for holding it at right angles to work.

Used for positioning and holding nose rib gussets at Glenn L. Martin plant, this device is stated to have reduced working time from 14 min. to less than 3. Further, it enables one man to complete work which formerly required labor of two.

Because hand layout is no longer needed, accuracy of finished work is considerably higher than before this tool was introduced by John Haines, inspector in PBM Mariner shops.

Design Details of

Metro-Vickers F/3 Turbojet

Ducted fan thrust augmentation is feature of new British unit which has 2-stage turbine compressor and two 2-stage contra-rotating turbines to drive fans.

By JOHN FOSTER, Jr., *Managing Editor, "Aviation"*

THRUST AUGMENTATION through use of contra-rotating fans is among the latest British turbojet developments.

Just revealed, the new unit, developed from the Metropolitan-Vickers F/2, is designated F/3 and develops, from the straight hot jet, 2,400 lb. static sea level thrust for a weight of 1,650 lb. and, with the fan augmentation, a thrust of 4,000 lb. for a weight of 2,200 lb. This gain in thrust is accomplished without any fuel consumption increase, the result being that the engine has a specific fuel consumption of 0.65 lb./hr./lb. thrust.

Basically the airflow is simple: Through a 9-stage axial flow compressor; into an annular combustion chamber; through a 2-stage turbine driving the compressor; through two 2-stage contra-rotating turbines driving the fans; then on out separate exhausts, the two streams joining at the jet pipe end.

Unlike most axial flow compressor casings, conventionally symmetrical in shape, the casing on the F/3 has a larger diameter at the intake than at the turbine end. It is built in four sections, which bolt together along axial flanges, with a circumferential flange at the sixth compressor stage. Stator blades—70 to a row—are peened into dovetail-section slots machined into the casing.

The starter motor and oil pumps are housed in a spinner-type fairing at the intake end, with the air entering the annulus between four concentric rings attached to faired spokes to form a grid. Other accessories are mounted atop the compressor casing, the drive being from a vertical shaft set just ahead of the front thrust bearing.

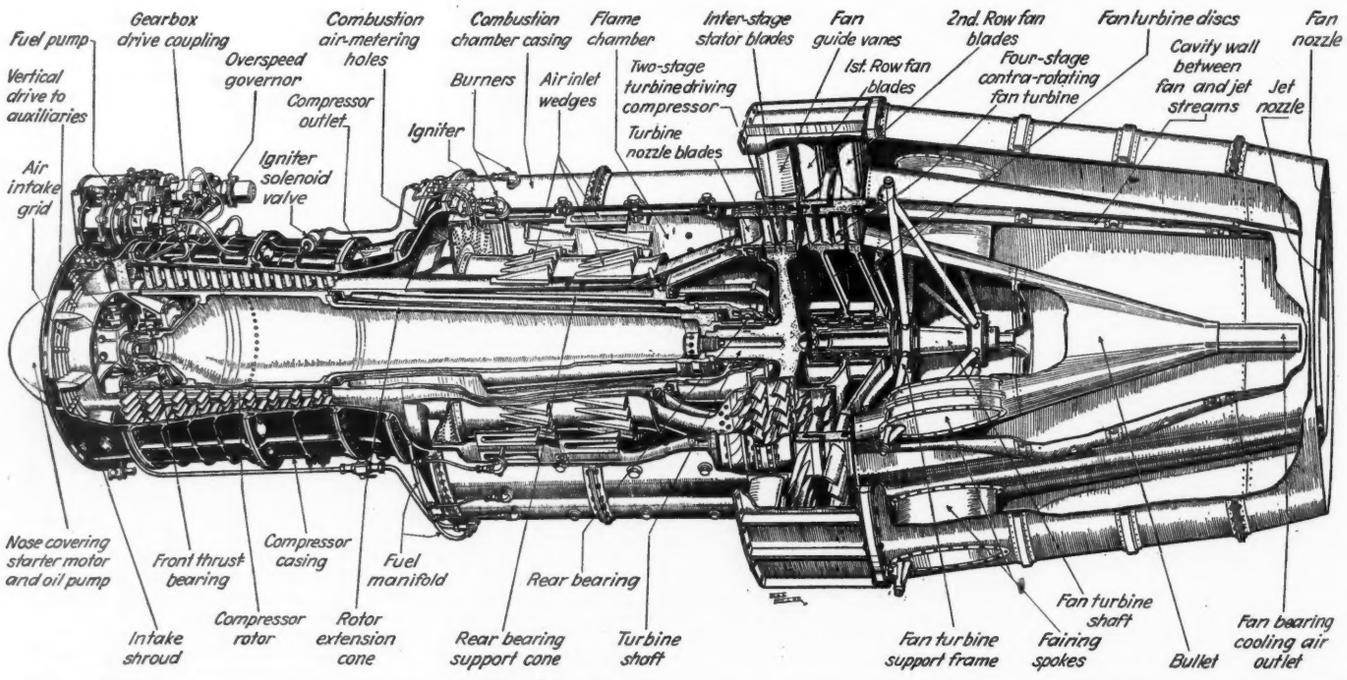
Drum of the compressor is a single piece forging with machined serrated slots in the outer surface taking the turbine blade roots, which are spaced by distance pieces and peened in place. There are 68 blades in each compression stage, all similar in design.

Bolted to a flange inside the compressor drum at the third stage is a conical diaphragm, the apex of which is attached to the front thrust bearing and which is splined to transmit power through a quill shaft to the accessories.

Also bolted to a flange at the downstream end of the compressor drum is another, but more elongated, cone which extends aft inside the annular combustion chamber, ending in an internally-splined sleeve that runs in the turbine bearing and houses the turbine shaft.

At the upstream end of the combustion chamber, a deflector ring divides the air into two annular streams, directing most of it around the flame tube, which is housed concentrically within the chamber. Both inner and outer walls of the chamber contain 80 wedge shaped inlets which are set in two staggered rows of 20 inlets each to admit the air into the flame tube downstream from the burners. Just downstream from the deflector ring is a circumferential end plate pierced by rings of small holes to meter and set up turbulence in primary air from the compressor. The 20 burners are plain shrouded tubes set 18 deg. apart with nozzles forcing fuel upstream at 650 psi.

The combusted gas moves through 56 turbine nozzle vanes; through the first



Cutaway drawing of Metropolitan-Vickers F/3 axial flow turbojet with ducted fan thrust augmentation—unit which gives specific fuel consumption of 0.65 lb./hr./lb. thrust. Shown are long conical compressor rotor extension, 2-stage turbine, and arrangement of two contra-rotating 2-stage turbines driving fans. (Max Millar sketch re-drawn from "Flight")

stage of the compressor turbine—which has 80 blades; then through a ring of 84 stator blades and through the second 80-blade stage of the turbine compressor.

This compressor turbine has a single disk with a T-shaped rim supporting both rows of blades, which are anchored by bulb type roots locked in place by peening.

Immediately downstream from the turbine compressor are two contra-rotating two-stage turbines for driving the fans. Disks of both fan turbines are swept forward, this to allow room for bearings at the hub and to get the blades close to the compressor turbine. Each fan turbine is carried on a pair of roller and ball thrust bearings, both sets running on a common shaft supported by a six-point tubular brace, which also supports the fan ducting and jet cone.

First row of blades of the first fan turbine are set just forward of the disk, with the fan blades being mounted on a ringed shoulder extending out from the blade tips. The second row of turbine blades is mounted on the downstream edge of an extension of the disk rim. The downstream row of the second fan turbine's blades are set in the rim right over the disk, with the upstream row being supported from the outside by a crown extending forward from the second row blade tips, this shoulder also supporting the second row of fans.

Thus the four rows of fan turbine blades are nested, with one row of each being interposed between the rows of the other. Since the blades are contra-rotating, the need for stator blades is eliminated. The first row of fan blades rotates at 2,850 rpm., the second at 2,300 when the compressor turbine is turning at its maximum of 7,600 rpm.

Air intake for the fans is an annulus, with inlet guide vanes located around the turbine compressor. Annulus overall diameter is 48 in. Air from the fans is exhausted through an annular tapered throat which surrounds the jet gas stream, but is separated from it by a double skinned wall which keeps the two air streams isolated until they meet at the jet orifice.

Cooling air—some of which is also used for lubrication—is taken from the fourth, sixth, and final compression stages and from the secondary air from the combustion chamber.

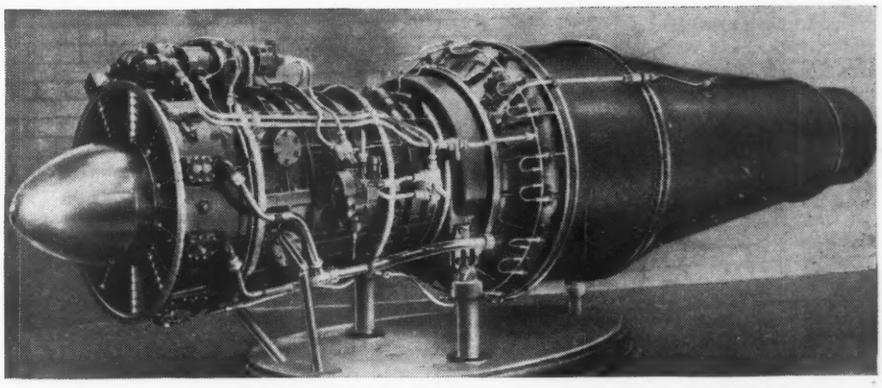
Radial holes drilled in the compressor rotor at the fourth stage take air inside the rotor, where it flows through the conical extension to energize an air-oil mixer to provide an oil spray for the turbine bearing. This spray is then evacuated through the cavity between outer and inner cone extensions, to be gathered in a circumferential duct around the outside of the compressor outlet, where it is vented to the atmosphere. External piping also supplies air for a similar air-oil mixer used to lubricate and cool the front bearing, the drain to the atmosphere being through a pipe inside bottom spoke of the air-intake shroud.

Additional air is bled off at the sixth compressor stage and ducted through the tubular members of the six-point fan-support frame to the interior of the hollow turbine shaft. Part of this air supply goes through an air-oil mixer to lubricate and cool the fan turbine bearings, the remainder being used to cool the downstream face of the compressor turbine disk and the upstream face of the forward fan turbine disk. Spray from the fan turbine bearings is exhausted into the tail cone bullet, escaping into the jet stream at the jet orifice.

Air from the final compression stage is bled through a channel between outer and inner cone extension to the front face of the compressor turbine disk, where a deflector plate directs it toward the center of the disk, from where it flows radially outward into the jet stream past the blade roots.

Some of the supply of secondary air for the combustion chamber is bled off to cool turbine blade tips and both roots and tips of stator blades, and also to cool the fuel nozzles. This latter air is taken into the shroud near the root and exhausted through vent holes near the nozzles.

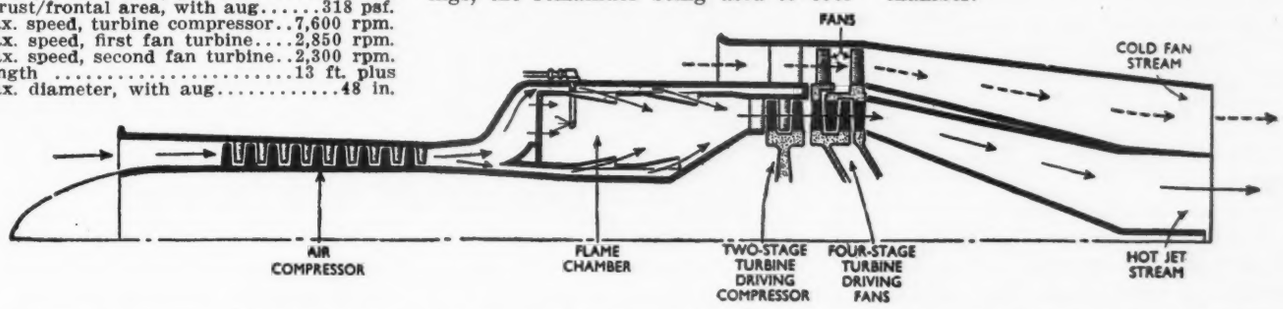
The F/3's fuel system is conventional, the fuel flowing from the tanks to a low-pressure filter to the suction side of the engine-driven pump, which sends it to the throttle valve. From here it is taken to a centrifugal governor and then to the main high pressure valve and the manifold. The now-usual barostat to regulate fuel flow according to altitude is used, being fed by a line from the pump. Another line, taken off just before the throttle valve, supplies a solenoid and two starting igniters set just off center at the top of the combustion chamber.



Metro-Vickers F/3 was developed from this F/2, which had 10-stage compressor and single-stage turbine. F/2 was first British axial flow unit to fly.

Specifications and Data

Thrust, max. SL, with augmentation	4,000 lb.
Thrust, max. SL, jet alone	2,400 lb.
Weight, with augmentation	2,200 lb.
Weight, jet alone	1,650 lb.
Specific fuel consumption (with aug.)	0.65 lb/hr/lb thrust
Thrust/frontal area, jet alone	321.5 psf.
Thrust/frontal area, with aug	318 psf.
Max. speed, turbine compressor	7,600 rpm.
Max. speed, first fan turbine	2,850 rpm.
Max. speed, second fan turbine	2,300 rpm.
Length	13 ft. plus
Max. diameter, with aug	48 in.



Cross section sketch from "Flight" depicts flow of air through 9-stage axial flow compressor, annular combustion chamber, 2-stage compressor turbine, and two 2-stage contra-rotating fan turbines. Air streams from hot jet and fans are kept separate until they reach jet orifice.

Instrument Research Demands Unremitting Efforts

By **CHARLES H. COLVIN,** *Consulting Engineer*

This graphic account of the 22 painstaking and costly steps required in the successful development of an aircraft instrument—from initial suggestion to final factory production—clearly points up the prime attention which must be given to the evolution of these devices.

BASICALLY, THE WORD "RESEARCH" has two connotations: To the scientist it means experimentation to establish data and/or test theory; to the industrialist it has a broader meaning—coverage of all the processes whereby a device or material is conceived and carried to the point where it is ready for production. The former is called scientific or fundamental research, the latter applied or industrial research.

There is a general pattern in all aircraft instrument research and development. It begins with recognition of the problem; and it ends, insofar as the research and development department is concerned, with the test of the prototype and approval of the finally revised specifications and drawings.

Sometimes the existence of the specific problem is initially recognized by the potential user—in the case of aircraft instruments, the military or civil aircraft operator. And sometimes it's noted by the manufacturer, designer, or research worker. But in any event the real starting point of all research or development is the formulation of a clear statement of the problem. Dr. Elmer Sperry used to say that a problem well stated was half solved. Easy or hard, the complete written statement of the problem is of utmost importance. Many have been the man-hours wasted in work on inaccurately or incompletely stated problems.

For example, when work was started on what later became the Sperry Turn Indicator, the problem was stated as the indication of lateral level. The first instruments had a horizontal indicator bar which was to remain laterally level, under the combined influence of gravity, a spring, and the gyroscope. When it became apparent that the problem was really the indication of rate of turn, the pendulous control was eliminated, a vertical hand was substituted for the horizontal bar, and the solution became quite straightforward. Accordingly, only five years of development was required to put a satisfactory turn indicator into production.

Once a problem has been clearly stated, the nature of the device for solving it is frequently obvious. With some problems, half a dozen solutions may appear equally promising, while with others no answer will be immediately apparent. Sometimes, when the customer or the sales department proposes a device which is not even theoretically possible, research and development temporarily give way to tact and diplomacy.

When the general nature of the solution has been determined, a specification should be prepared, though in many respects it must be tentative. It is desirable to divide the specification into three sections: Structural, performance, and economic. Structural requirements should be kept to a minimum. In an aircraft instrument intended for panel mounting, however, they must include mounting dimensions, weight limit, dial illumination, and the voltage and the cycles on which the instrument is to operate.

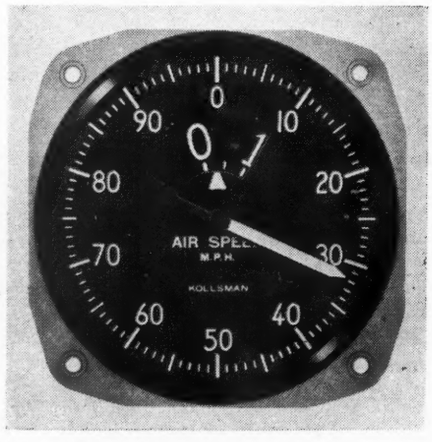


Fig. 1. Before development of this design, the size, cost, and maximum calibration error had to be determined.

Operating characteristics and permissible limits of error will be covered under performance.

Structural limitations must not prejudice performance. There is, for example, a famous government specification in which the material, cross-section, diameter, and number of turns of a hair-spring are set forth—and then the performance is specified in terms of torque vs. angular displacement.

Permissible unit cost in an anticipated quantity come under the economic section.

Rarely will it be possible to be definite on all points; but the more complete and precise the initial specification, the less the development cost is likely to be. For example, when Kollsman undertook the development of a sensitive air speed indicator (Fig. 1) it was determined in advance that the size should be that of a standard 3⅛ in. case 4 in. deep, that the maximum calibration error could be 2 mph., and that the price could not exceed $50.

Another reason for preparing the specification with great care is that, after approval by all concerned—normally, the customer, management, sales, engineering, and research groups—all are committed to it, and changes require the approval of four or five groups.

Up to this point, the project has been a cooperative effort of user, seller, and engineer or scientist, but from now on it becomes the responsibility of research and development.

First task is to determine whether the project may be solved by the application of known engineering principles or

techniques, or if it will require fundamental research. Also management and the research director should want an estimate of the man-hours of research and engineering likely to be required.

Next is the preparation of a proposal to management. If research is indicated, it will be suggested that the required work be undertaken, to be reviewed for continuance or termination after x weeks or after the expenditure of y man-hours. If it appears to be a straightforward engineering job, it will be estimated that the work can be done in x weeks using y man-hours. Generally these estimates will be broken down into drafting, laboratory, experimental shop, and flight test time.

Now comes management's big decision —to risk or not to risk. A wrong decision made promptly may cost less than the right decision too long delayed. Frequently, approval must also be secured from the customer, and he also will do well to act quickly. If a project can be started while the preliminary study is still fresh, much time is saved.

Once approved, and with funds appropriated, the project returns to the research and development. A detailed study is made and the project is broken down into its essential components, each of which is allocated to an individual or group for study. It is not unusual for one or more phases to be entrusted to some outside agency.

An excellent example of such a component study is to be found in the development of the Kollsman electrically heated pitot static tube (Fig. 2). Basic divisions of the project were aerodynamic, structural, and thermal. The group studying aerodynamic problems called on the NACA and on the AAF for assistance. The structural group studied methods of fabrication, an electro-depositing process having been settled upon as most promising. The thermal studies were made in cooperation with the Goodrich Co., employing that company's icing wind tunnel.

The Pioneer Air Position Indicator provides another good example. This project was allocated among staff members, who thereupon studied the separate problems of air mileage measurement, adaptation of compass indications, and computing mechanism.

Completion of such studies should bring the project to the point where a preliminary layout can be started. If not, it is a good time to reappraise the whole undertaking, and to tell the management the bad news, either getting an extension of time or funds, or both—or agreeing that it is one of those unfortunate projects that had better be abandoned before any more time and money is spent.

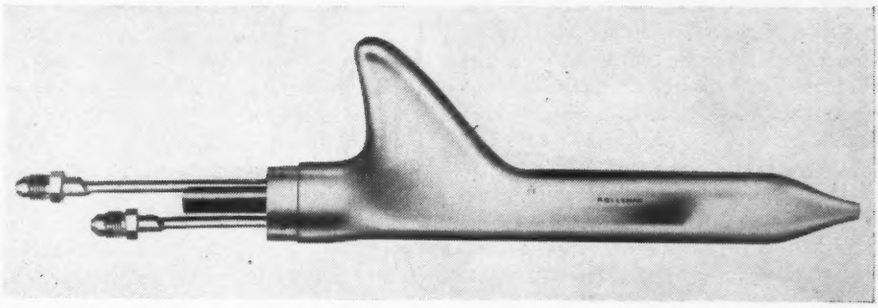


Fig. 2. To design this seemingly simple Kollsman electrically heated pitot static tube, project was divided into aerodynamic, thermal, and structural sections. NACA and AAF were also called upon for assistance, while experimental work was performed in Goodrich icing wind tunnel.

Assuming that the study and reassembly of the components has indicated a clear path to be followed, the preliminary design is then undertaken.

This leads to, or may be concurrent with, the construction of a "breadboard" model or a mockup, the tests of which will provide data for the design of the experimental unit.

Examples of such models can be drawn from everyone's experience. Either of the Fairchild versions of the A.P.I. might be cited. In the mechanical device, a rough sample gear set was built up with the necessary differentials, with a variable throw ratchet controlled by a cosine mechanism. In the electrical system the various elements were similarly strung out on a board.

For many instruments, a wooden or plaster mockup aids in the placement of control knobs and other elements, for best visibility or for greatest convenience.

Depending on the nature of the device, the model may or may not have a close relation to the final form of the apparatus. Here is found a wide difference of opinion as to the desirability of attempting to introduce production thinking. Some persons insist that the production engineer be brought in at this stage so that the ultimate design may be easier to build. Others feel that the men who do research, development, and experimental work are better left uninhibited. To the production man anything new is suspect, while it is the job of the researcher to do new things or to do old things in new ways.

To quote from Professor Bichowsky's excellent book on industrial research: "The primary difference is in point of view. The research man, if he is worth anything, must be able to find the grain of gold in the pan of gravel; the production engineer must be able to see the fly in the ointment." Better results have been obtained by keeping the production engineers in the background at this stage of the project. A more important consideration is the possibility of building the experimental design quickly and easily with available facilities.

Next comes construction of the experimental unit which, if the company be well organized, will be in an experimental shop.

With completion of the experimental unit, which will probably be assembled

Necessary Steps in Pattern of Instrument Research And Development

Operation	Responsibility*
1. Recognition of problem to be solved	C, S, or R
2. Formulation of statement of problem	C, S, or R
3. Proposal of general nature of device to solve problem	C, S, or R
4. Preparation of specifications for device	C, S, or R
5. Approval of specifications	C, M, S, and R
6. Study to determine if only application of known engineering principles and techniques will be involved, or if research—that is, discovery of new principles or techniques—will be required	R
7. Proposal (a) if research; That work be undertaken to be reviewed for continuance or termination after x weeks or expenditure of y man-hours; (b) if engineering: That job can be done within x weeks, using y man-hours	R
8. Approval of proposal and appropriation of funds	M (and C)
9. Detailed study and breakdown of project, with allocation of component problems	R
10. Preliminary design	R
11. Construction and tests of "bread-board" models and mockups	R
12. Experimental design	R
13. Construction of experimental unit	R
14. Tests of experimental unit	R
15. Re-design of experimental unit	R
16. Construction of re-designed unit	R
17. Tests of re-designed unit	R
18. Design of prototype	E
19. Construction of prototype	F
20. Tests of prototype	R (and S or C)
21. Revision of specification	C, S, and R
22. Approval of revised specifications	C, M, S, R, E, and F

*Code: C customer, M management, S sales department, R research and development dept., E production engineering dept., and F factory.

in the laboratory, the comprehensive test program begins. Coincident with the design work, and based on the performance characteristics stipulated in the specification, the testing should have been planned so that it may follow a logical pattern. While the types of tests will be dependent on the nature of the device, in general they will be directed to a determination of the instrument's calibration, its accuracy and precision, its performance at high and low temperature, its power consumption, the effects of vibration on its indication, and on the wear of its parts, etc.

Testing may represent a very large part of development costs. Laboratory tests, for example, on the Sperry Model A-12 Gyropilot covered a period of three years and required thousands of man-hours, in spite of the fact that Sperry had been making automatic pilots since 1912 and had produced many prior models.

Assuming that performance in the laboratory gives promise of ultimate success, flight tests will be planned and carried out. Here, careful planning and the preparation of a test pattern is doubly important because of the cost of airplane operation and the difficulty of going back to fill in missing data.

To continue the example of the Sperry A-12 Gyropilot, flight tests on the company's own planes ran to several thousand hours; and later tests on other planes, requiring the presence of Sperry engineers, involved several hundred additional hours of flying.

Even on such a relatively simple device as the Kollsman Angle of Attack Indicator (shown in Fig. 3) initial flight tests required 50 man-hours of installation and 30-hr. of flying. A further series of tests on a military type plane took 200 man-hours of installation and 60 hr. of flying. Computations and analysis of the results accounted for another period of about 150 man-hours.

If the first experimental unit is found to be somewhat less than perfect, its re-design is next in order; then comes the reconstruction of the unit or the building of an entirely new one. Even if the first unit could be altered, building of a new one is often desirable, so that comparisons may be made between the two models, should the second one exhibit some fault not observed in the original test. Laboratory tests of the second unit must be as thorough as those of the first, for it is unsafe to assume that the changes made to correct one fault may not have altered another characteristic which was originally satisfactory. Then the scene shifts to the airplane, where flight tests will be repeated.

Redesign, reconstruction, and retest may have to be done again and again, but the pattern remains as described; and eventually, one hopes, the head of the research and development department will place the completely successful experimental model on the chief engineer's desk and say, "This is it."

At this point, the production engineers go to work, and here we have one of the most crucial moments in the life of the new device, for human factors play as large a part as things technical or scientific. The baby is acquiring foster parents, with accompanying emotional stress. The utmost cooperation is necessary between those who conceived, designed, and tested, and those who will redesign for production. The production man cannot know, unless he is told by the man who did the development, whether the shape of a part may be changed to facilitate production, or whether it was made that way after many trials. Close fits in an experimental model may be quite impossible in production, through accumulation of tolerances.

Complete redesign may be required to obtain, in production, limits resulting from hand fitting in the experimental model. Between the details which cannot be changed and those which must be changed, there may be many which the production man will want to alter to conform with standard shop practices. He will also avoid parts which are almost but not quite symmetrical, and which therefore might be reversed in assembly, etc. From much give and take will come a product retaining the features of the experimental unit, but with parts designed for economical fabrication and assembly.

We are now approaching the end of the process of creating a new instrument. From the production drawings at least one prototype will ordinarily be made. Frequently it will be desirable to make a small pre-production quantity in a jobbing or small-quantity shop.

Of the prototypes, the first will go to the laboratory for repetition of the tests which were made on the experimental units, then to the airport for final flight tests, after which this instrument (or one of the identical prototypes) is ready for submission to the customer.

Finally, unless the original specification was drawn with more than ordinary prescience, the customer, sales, research and development, and production people will get together on revised specifications which management will accept as the criteria for that product.

All these 22 distinct steps in the research process (see accompanying table) take time and cost money. During the war, many research and development expenses were inextricably merged with production costs, giving research a "free ride." But now research must have its own budget. Unless there is adequate appreciation of the cost of research and development, instrument makers and their customers are both heading for trouble.

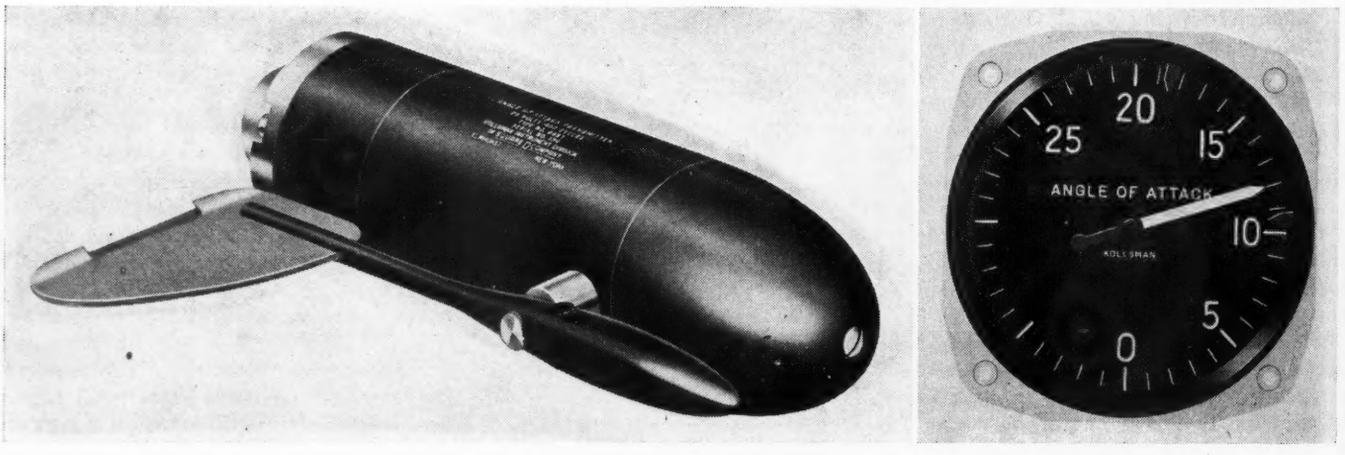


Fig. 3. This angle of attack indicator—device and dial—required total of 250 man-hours for installation alone. Then flight testing took over 90 hr., after which 150 hr. were expended in computing and analyzing results.

Develop Potent Rocket Engine For Navy's Supersonic Planes

New light liquid-fuel power plant, rated at 6,000 lb. thrust, is culmination of four years of research for BuAer by Reaction Motors, Inc.

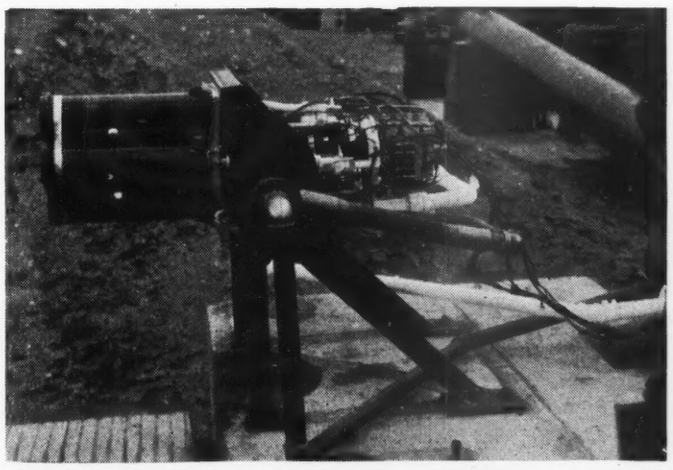
DESIGNED EXPRESSLY to power supersonic aircraft, a new liquid-fuel rocket engine weighing but 210 lb. and said to be capable of delivering 6,000 lb. thrust at sea level has been developed by Reaction Motors, Inc., of Pompton Plains, N. J., in conjunction with the Navy Bureau of Aeronautics.

Designated the 1500N4C, the engine basically consists of four cylinders, each capable of delivering 1,500 lb. thrust. Each cylinder contains an igniter combustion chamber and expansion nozzle. The propellents consist of a specially developed alcohol compound for fuel, and liquid oxygen as an oxidizer.

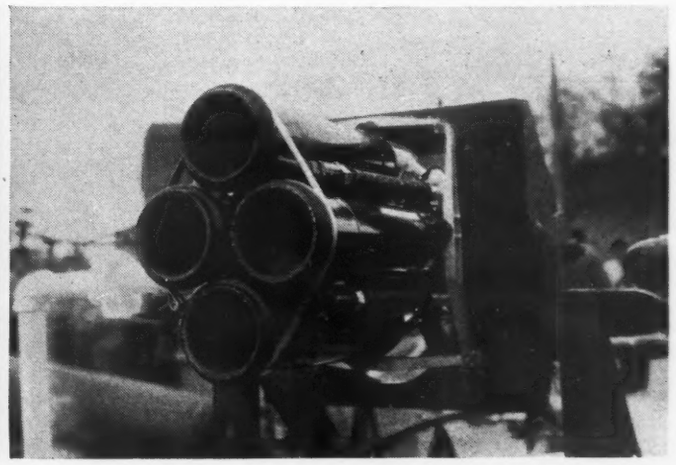
This development paralleled that of the German Walter rocket engine used in the Me-163. However company officials state that the new engine is so much more powerful that if it were employed in an Me-163 the craft would be destroyed. Far greater operating efficiency is also claimed for the 1500N4C.

At the present time, rocket engines provide comparatively short duration of power because of their extremely high fuel consumption. It is notable, however, that since they carry their own oxygen for combustion, no atmospheric limitation on their operational altitude is seen.

Flame spurts from engine as one combustion chamber is activated. Ignition is by means of an electric arc. At left is operator at control stand. At right are fuel tanks, large silver tank containing liquid oxygen and dark slim one holding alcohol mixture. (Aviation photos.)



Mounted on test stand, Reaction Motors new 1500N4C rocket engine displays its compactness. Its size belies its power. Company officials state that it produces 6,000 lb. thrust at sea level. Notable is frost (caused by temperature differential) on pipes carrying liquid oxygen.



Expansion flare of nozzles is evident in this view of engine's four cylinders, each of which contains an igniter combustion chamber. Company has spent four years in developing this power plant for Navy supersonic fighter planes.

LIQUID MASS MEASUREMENT UPS FUEL GAGING ACCURACY

By CARL H. ODELL, *Assistant Manager, Instrument Division, Thomas A. Edison Industries*

Increased payload—instead of extra fuel—is only possible when tank gages can be depended upon to give accurate readings. Described here is new device which approaches optimum in liquid measuring through electronic determination of C. G. of liquid at any airplane position.

EVEN IN THE DAYS when airline travel seldom comprised non-stop distances of over 1,000 mi., study of the effect of fuel weight on payload was a full time job for competent engineers. Now that transocean flights have become commonplace, this subject is of paramount importance in the air transport field.

A considerable proportion of the excess fuel which normally is carried on long distance flights would not be required if inaccuracies in measuring the contents of the tanks while in motion could be overcome. It has been estimated that a fluid measuring device which would enable this excess fuel weight to be reduced by one-half would permit an additional payload revenue of $2,500 on an Atlantic round trip.

Though closer accuracy can be obtained by measuring weight, rather than volume, this method is not applicable to moving aircraft, but a near approximation to the true contents of a tank can be had by measuring mass instead of cubic contents.

Mass determination by capacitance change indication has recently been used for fuel measurement with a high degree of accuracy, and because of the small amounts of current involved fire hazard has been eliminated.

The Edison Liquid Gaging System is fundamentally a capacitance bridge with a ratiometer across the bridge (see Fig. 1). One leg of the bridge comprises the measuring condenser plates immersed in the liquid to be measured, while the second leg is a fixed condenser used for reference. The other two legs are the R.F. coils in the vacuum tube circuit (see Fig. 2).

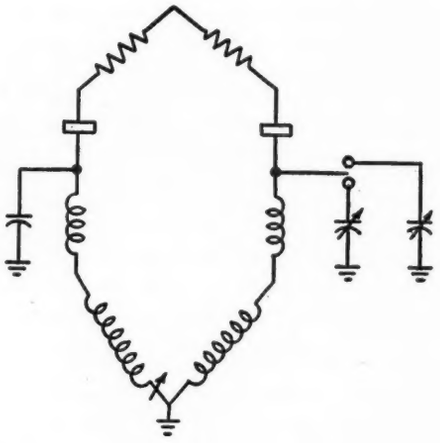
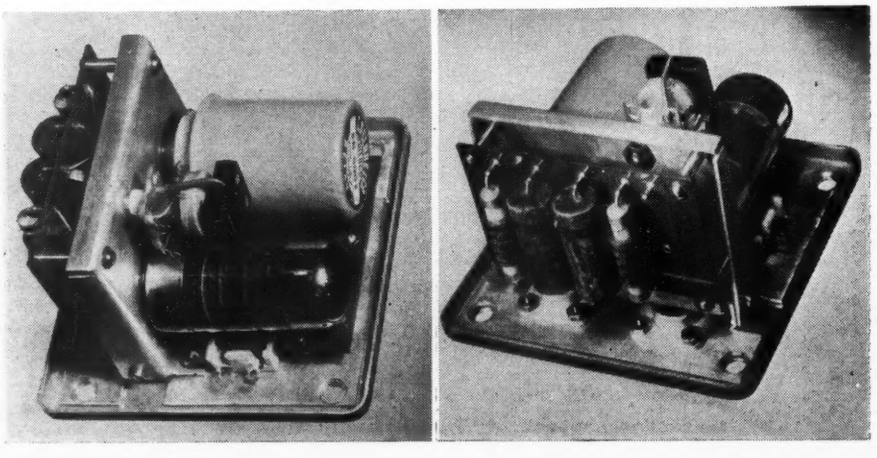


Fig. 1. Bridge circuits of Edison liquid measuring system. On left is reference circuit which has same capacitance as fully immersed measuring circuit on right. As fuel (or other liquid being measured) is withdrawn from tank, bridge becomes more and more out of balance and ratiometer indication varies directly with relative capacitance. Water gaging circuit (extreme right) is cut in by pressing button.



Two views of simple, electronic transmitter used in Edison Liquid Gaging System. This device receives micro-ampere current from tank units and transmits variations to indicator on instrument panel.

Capacitance of the fixed reference condenser is equal to that of the measuring condenser when fully immersed, but any lesser amount of liquid in the tank will produce unbalance between the two legs of the bridge, this differential being used for the purpose of operating the indicating means.

A test circuit and water detection circuit incorporated in the indicator are actuated by pressing a button, thus providing the pilot with a means for checking the functioning of the gaging circuit at any time, and without interference with the flow of fuel to the power plants.

Absence of any moving parts (except the moving magnet in the indicator) and the use of micro-ampere current give

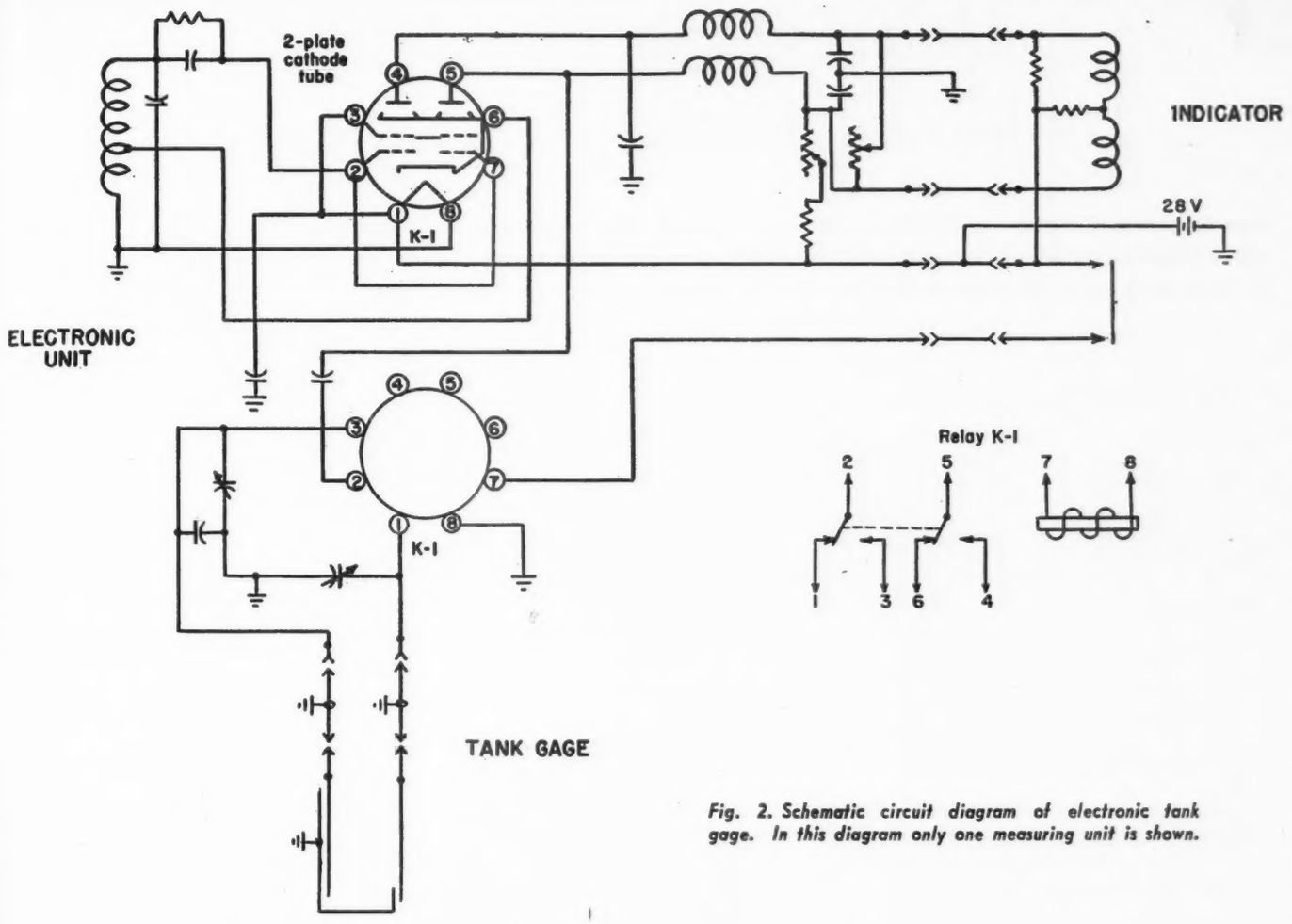


Fig. 2. Schematic circuit diagram of electronic tank gage. In this diagram only one measuring unit is shown.

this gaging system extreme reliability and safety.

Because this device uses mass rather than volume as a basis of measurement and because mass can be regarded as being concentrated at the C.G. of a body, it is only possible to obtain close accuracy by locating measuring devices as close as possible to the C.G. of the liquid (see Fig. 3). The C.G. is also constantly changing, both through movement of the position of the airplane and because fuel is being withdrawn by the engines. For these reasons, the position of the measuring devices must be determined to suit each individual tank shape and size, since a slight error in the placement of one unit might nullify the exactness of the rest of the installation.

Tank elements are condenser plates, insulated to form a dielectric gap. Variation of capacitance of these elements is adapted for each installation. For the majority of tanks, which are of unsymmetrical form and have a variable liquid drop, profiled sheet angles have been found to offer the greatest variation in capacitance changes. Because the overall accuracy of any remote measuring device is no better than that of the actual measurement, the shape of the condenser elements is designed to give a capacitance equal to the mass at any point, and these elements are so located that tilt conditions do not materially affect the linear capacitance-mass relationship of the fluid contents of the tank.

Readings are independent of temperature, altitude, barometric changes, or the attitude of the aircraft. Surges caused by transient accelerations, either linear or angular, have only an instantaneous effect with respect to the indications.

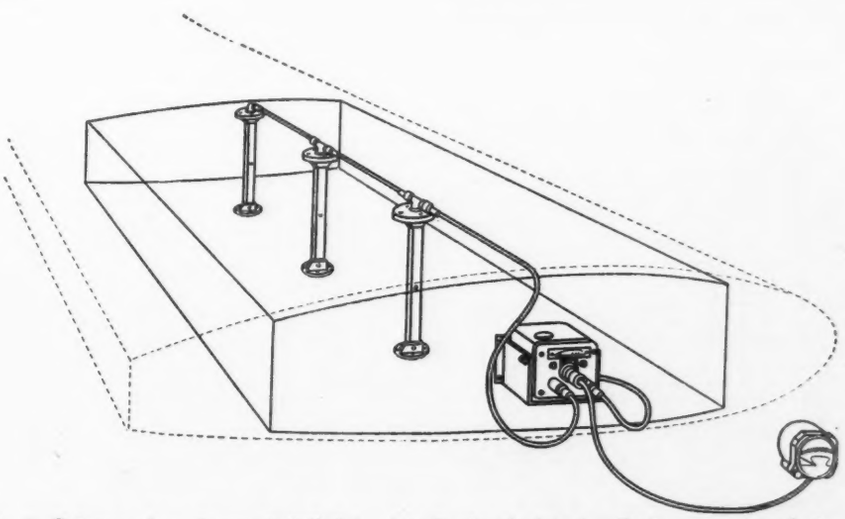
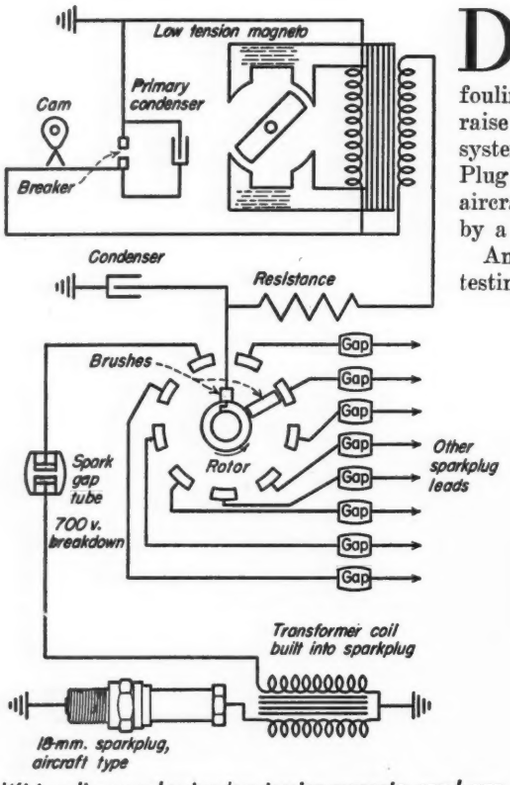


Fig. 3. Cutaway view of gage installed in aircraft wing fuel tank. Center measuring device is at C. G. of mass when approximately level. Outside units are at C. G. of mass at ends of tank, thereby giving more accurate indication when tank is tilted. Number and location of units depend entirely upon shape of tank. Electronic unit is shown on end of tank. Indicator may be located in any convenient position.

Unit System of Ignition Aims at Better Performance

Ingenious installation—complete with low tension mag, distributor, spark gap tube, wire, harness, and transformer type sparkplug—is AC's answer to engine operation ills.



Wiring diagram showing low tension magneto, spark-gap tube, and transformer type sparkplug used in new AC aircraft engine ignition system.

DESIGNED TO PROVIDE easier engine starting in sub-zero weather, overcome difficulties of sparkplug fouling, eliminate corona effects, and raise operating ceilings, a new ignition system produced by GM's AC Spark Plug Div. is the first such complete-unit aircraft installation to be brought out by a single manufacturer.

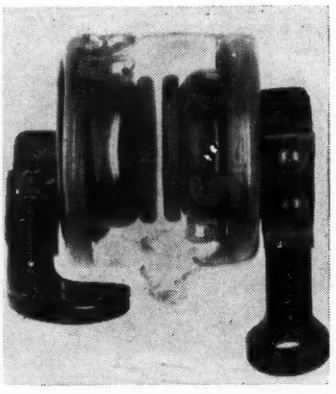
And after thousands of hours of AAF testing, AC now plans to produce the installation for commercial transport planes.

Low tension magneto is used, interchangeable for size with standard H. T. unit, but differing from latter in windings and distributor construction, and by addition of a condenser and cold cathode breakdown (spark-gap) tubes.

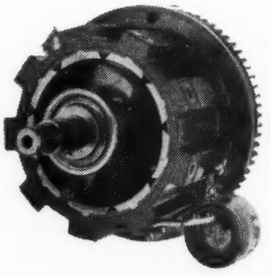
Current from magneto is delivered to brush type distributor head, from which leads go to each breakdown tube (equipped with special barium electrodes with gap set for spark to jump at 700v.) and to sparkplug. Encased in the ceramic insulator of the latter is a miniature step-up transformer.

Electrical energy generated by the magneto is stored in condenser until supply is great enough to jump tube spark gap, delivering a surge of current to the transformer in the plug.

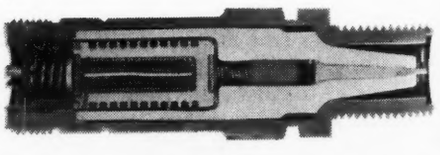
Engines using this ignition system have been run 500 hr. without cleaning or re-gapping of plugs, and electrode wear has been approximately .003 in./100 hr. service.



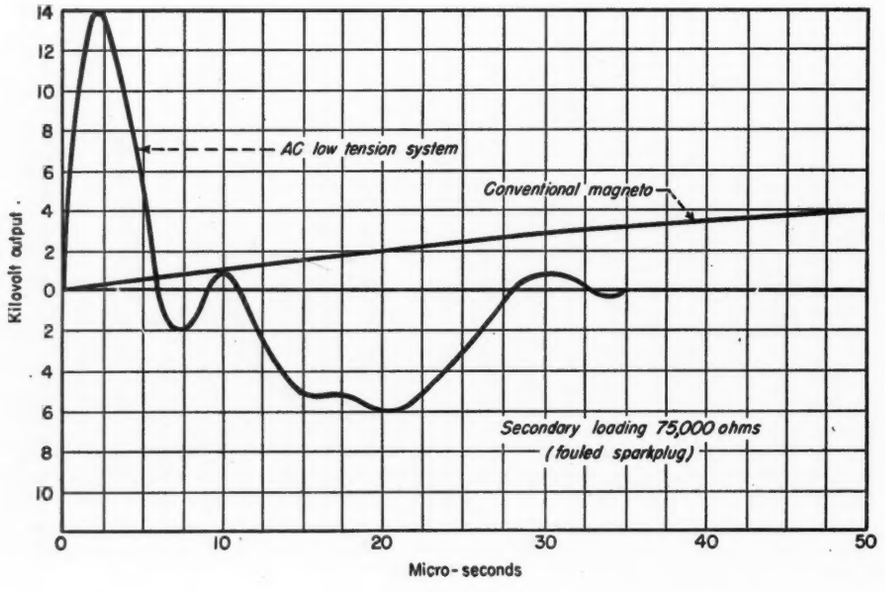
Close-up of spark-gap tube showing large area of plates, also terminals which attach it to distributor head and sparkplug lead.



Seen here is distributor head on AC low tension magneto with its metal-graphite brush which makes positive contact for distributing current to cylinder. On one terminal is mounted spark-gap tube, and similar units are used on each sparkplug lead.



Section of new AC sparkplug featuring tiny transformer built into ceramic insulator. Plug, of 18-mm. size, is interchangeable with standard aircraft plugs.



Performance curve showing tremendous speed with which sparking current builds up to maximum voltage, compared with that of conventional high tension system. Note that latter has not reached 1/3 voltage when current has been flowing ten times as long as with new system.

Instrument Shock Mount Adapted for Personal Planes

Low-price suspension type giving three-way vibration absorption is designed for current-craft installations and components. Meantime, larger units are being supplied for airliner uses.

UTILIZING A BACKLOG of experience obtained in building more than 200,000 shock mounts for combat aircraft, Robinson Aviation, Inc., has developed a line of units for personal and commercial planes. Employed is the company's Vibrashock principle (first described in Nov. 1944 AVIATION).

This principle provides for three-way freedom of movement, designed to absorb more than 90%—actually it is closer to 100%— of all vibration, taking up shock in both horizontal and vertical planes. In some conventional mounts a vertical shock, for example, can be absorbed but lateral movements will actually be amplified.

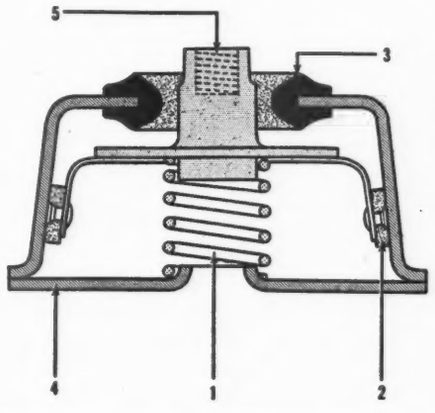
The new Robinson mounts utilize a stainless steel coil mainspring; four flat springs working against the mount housing to kill low frequency oscillation and minimize resonance at critical frequencies; three-way snubbers providing a resilient stop to limit heavy shock loads; and a load-carrying central stud which is tapped for standard machine screws.

The mount base has standard attachment holes, and the unit is designed to be interchangeable with conventional mounts so that no re-design is necessary for installation in either current equipment or in aircraft. Some panels can be successfully mounted with but two of the units and a stabilizer. For example, C. S. Robinson, president of the company, has mounted the flight instruments in his own Fairchild 24 on two of the units, on on either side, combined with a stabilizer at the top. His radio is mounted on four units, one at each corner, with a stabilizer at the top. Flight demonstrations conducted for an AVIATION Correspondent showed almost complete vibration absorption through all engine speeds and in taxiing over a rough field.

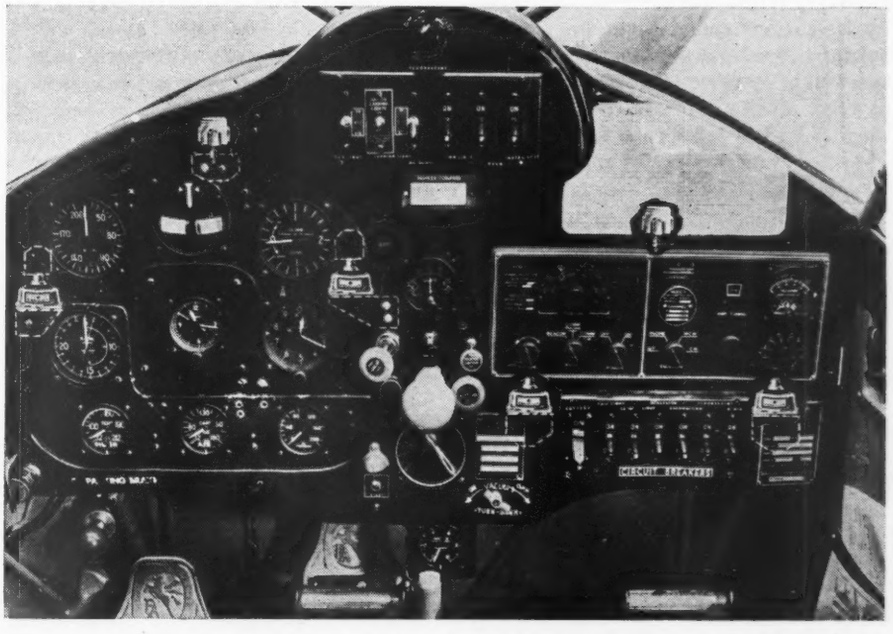
Currently the company is producing the Vibrashock units in three series—one ranging from rated loads of 0.5 to 4 lb.; one from 4 to 12 lb., and another from 10 to 45 lb. The smallest unit weighs 0.69 oz., while a typical unit in the second series weighs 1.77 oz.

While the smallest shock mounts have been designed especially for radios and instruments of personal planes, the larger units are being installed in radio units of many airliners where continuing service tests have already passed the nine-month mark without tube failures, whereas tube life had formerly averaged but ten days.

The larger units are also being used to shock-mount the cabin supercharging and ventilating equipment of a new airliner now under development, and Robinson engineers are working with designers of another forthcoming airliner to determine the possibility of shock-mounting the entire passenger cabin within the fuselage, not only to reduce vibration, but to further soundproofing.



Cross section of Robinson Vibrashock unit, showing (1) three-way freedom of main stainless steel spring unit; (2) damper unit attached to flat spring for cutting low frequency oscillation and minimizing resonance at critical frequencies; (3) rubber snubbers to provide resilient stop to limit heavy shock loads; (4) lightweight metal housing provided with standard attaching holes in base; and (5) load carrying stud tapped for standard machine screws.



Cutaway view showing installation of flight instrument panel (left) and radio (right) in Fairchild 24. Instrument panel is mounted on two Vibrashock units, one on each side, with stabilizer at top, while radio is mounted on four units with stabilizer.

Case For The Full-Pneumatic System

PART II

By JAMES L. DOOLEY, *Project Engineer, Harvey Machine Co.*

Concluding his cogent presentation, the author analyzes system weight factors, outlines service and experimental air usages, and finally details typical air systems for large twin-engine and light single-engine craft.

IT IS EXTREMELY DIFFICULT to compare accurately the weights of the three auxiliary power systems—hydraulic, electric, and pneumatic—since complete information is seldom available and factors must be assumed. Because of this, any weight-comparison studies between these systems must be approximations, and they show trends only. Power generation, transmission, storage, and consumption are compared separately.

Curves are not available for comparing the compressor and unloader with a hydraulic pump and pressure regulator or with an electric generator and voltage regulator, because so few models of air compressors for aircraft service have been built.

In general, the compressor for the pneumatic system will weigh about twice as much as the pump of an equivalent hydraulic system. It should be emphasized that this comparison is for an equivalent system and not per unit of output power. However, extra compressor weight is more than offset by other savings. Since the demand for lightweight, high-speed compressors is comparatively recent, it is reasonable to assume that the compressor weight will be reduced as the art of building these aircraft type units progresses and new designs are brought out—a situation similar to the development of aircraft hydraulic and electrical systems.

Power transmission is compared in chart shown in Fig. 6 of Part I (page 70 May AVIATION). Fig. 7 (Part I, same page) and Fig. 15 herewith not only show that pneumatic energy can be transmitted with the efficiency and weight of hi-cycle a.c. power, but also that high pressures are not required as in a hydraulic system. Obviously, these curves will vary somewhat with different insulation and tubing materials, but they do show that air is more than competitive.

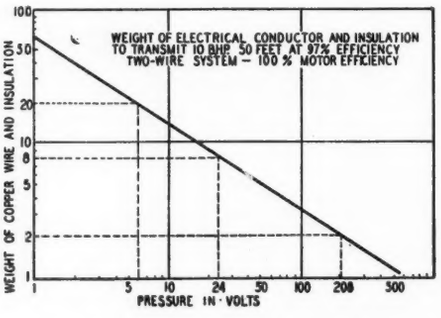


Fig. 15. Graph of power transmission.

Weight comparison of energy storage devices is shown in Fig. 8 of Part I (page 70 May AVIATION). When energy is withdrawn from a battery at the slow drain rate, there is considerable weight advantage over a pneumatic receiver or hydraulic accumulator. However, in almost every instance the energy is required rapidly—in some cases, almost instantly. When the withdrawal rate is high, the total energy obtainable from a battery is as low as 15–20% of the maximum obtainable when the withdrawal rate is low.

In an air receiver this is not so. The air receiver (and hydraulic accumulator) can give up *almost* as much total energy instantly as when withdrawn slowly. Actually, there is cooling of the air because of adiabatic expansion when the withdrawal rate is high, reducing the total energy available. The amount of cooling depends upon the expansion ratio. This is a material advantage for receivers (and accumulators) in aircraft use, where engine starting and landing gear operations are short-time heavy loads.

Also, low temperature adversely affects battery operation. The energy available not only falls off rapidly with lower temperature but at such temperature the battery cannot be fully recharged. In a receiver the pressure drops because of contraction during cooling, and the energy available is thereby lowered, but the unit can be recharged to full pressure.

Weight comparisons of rotary motors are shown in Fig. 16. All of the electrical units are for intermittent duty, whereas the hydraulic and pneumatic motors can stall under load and stand without damage. Pneumatic motor size, even for low pressures (90-250 psi.), is small—a 6-bhp. 8,000-rpm. vane type motor using 250 psi. air pressure being of about 2½ in. dia. and 4½ in. long.

A pneumatic cylinder will weigh slightly more than a hydraulic cylinder (less oil) for the same job because built-in lubrication is required and, also, the diameter is larger. Contrary to the condition in hydraulics, where the weight of oil in a cylinder varies inversely with the design operation pressure, pneumatic cylinders require the same weight of air to handle a given force and stroke regardless of design operating pressure. Higher pressure cylinders are smaller and have less volume, but the air is more dense.

For example, the handling of 10,000 lb. force with 1-ft. stroke requires a 5-in. bore and 500 psi. air pressure, with cylinder volume of 240 cu. in. at this pressure (0.35 lb.). The variation in metal-weight of cylinders with pressure depends upon so many factors, including the whim of the designer, that it is difficult to make a direct comparison. In the range from 300 psi. up, it has been found that properly designed large-bore low-pressure cylinders are only slightly heavier than small-bore high-pressure units for the same job.

Most cylinders are designed to withstand full receiver pressure even though satisfactory operation requires much less. Obviously, for this low pressure, large-bore-cylinder steel walls of proper thickness are, from the stress viewpoint, much too thin to be practical in manufacture or use. This indicates that aluminum, magnesium, or even plastic-bonded material should be considered to obtain minimum cylinder weight. Some of these materials may stand up without lubrication and be corrosion-resistant.

Aircraft Uses of Air

There are three major factors which influence the design and application of

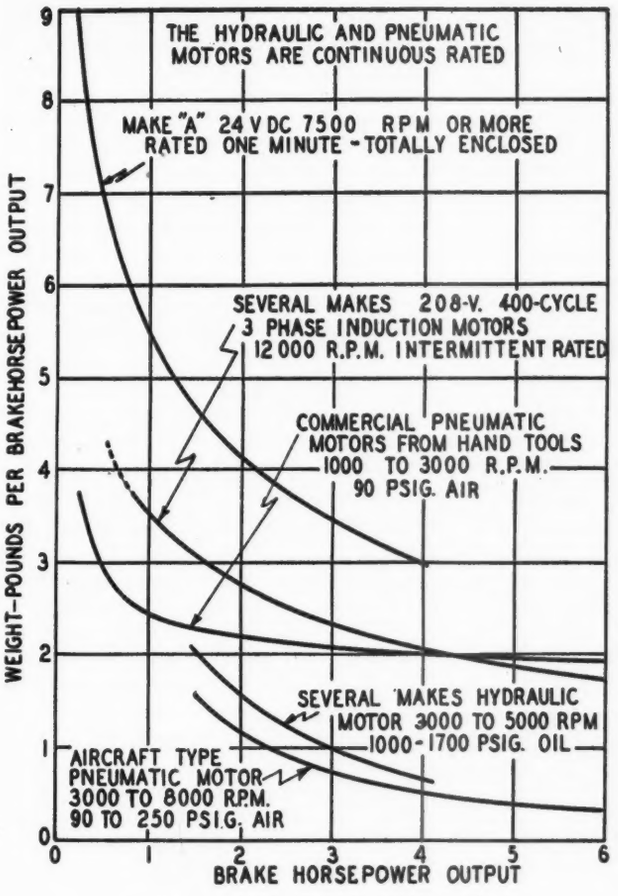

THE HYDRAULIC AND PNEUMATIC MOTORS ARE CONTINUOUS RATED
MAKE "A" 24 V DC 7500 RPM OR MORE RATED ONE MINUTE - TOTALLY ENCLOSED
SEVERAL MAKES 208-V. 400-CYCLE 3 PHASE INDUCTION MOTORS 12 000 R.P.M. INTERMITTENT RATED
COMMERCIAL PNEUMATIC MOTORS FROM HAND TOOLS 1000 TO 3000 R.P.M. 90 PSIG. AIR
SEVERAL MAKES HYDRAULIC MOTOR 3000 TO 5000 RPM 1000-1700 PSIG. OIL
AIRCRAFT TYPE PNEUMATIC MOTOR 3000 TO 8000 R.P.M. 90 TO 250 PSI.G. AIR
WEIGHT-POUNDS PER BRAKEHORSEPOWER OUTPUT
BRAKE HORSEPOWER OUTPUT
0
1
2
3
4
5
6
7
8
9

Fig. 16. In this graph are shown weight comparisons of rotary power units.

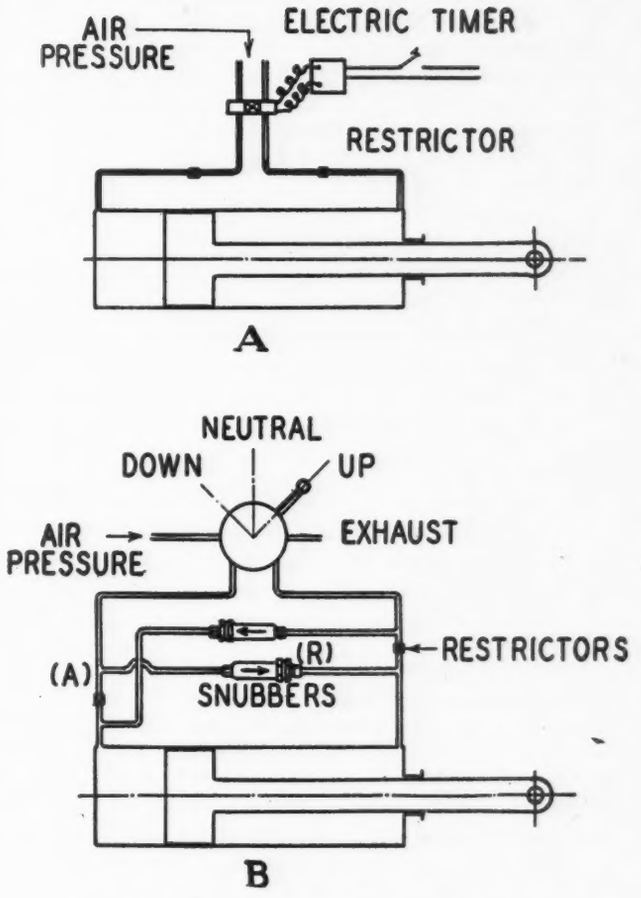


Fig. 17. Schematic diagrams showing methods of injecting cushion air charge.

aircraft equipment using compressed air:

1. Air has practically no lubricating properties, since most oil and water are removed in receivers. Hence, all equipment must be either self- or non-lubricated as well as corrosion-resistant.
2. Air is compressible to a much greater extent than hydraulic fluid.
3. Water vapor is taken into system by compressor and must be controlled to prevent malfunctioning of equipment because of freezing at low temperatures.

However, the use of compressed air in the aircraft installations listed below shows how versatile this fluid actuating medium can be when properly applied. Asterisks are used to indicate those units for which air has been employed in actual service, whereas most of the other installations specified have been air-actuated experimentally.

1. Landing wheel brakes.*
2. Landing gear actuators.* (Also for combined retraction and springing for lightplanes.)
3. Tailskid.
4. Wing flaps.*
5. Cowl flaps.*

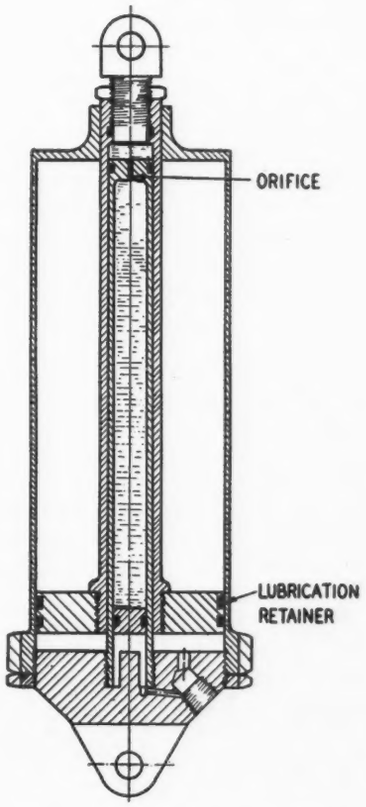


Fig. 18. Diagram of air cylinder with hydraulic damping.

6. Dive brakes.
7. Remote valves.
8. Starters for reciprocating engines and gas turbines.
   a. Air injection starter.*
   b. Pneumatic motor-driven inertia starter.
   c. Direct-cranking air turbine.
9. Gun charger.*
10. Water rudder.
11. Installations requiring static charging.
   a. Engine ignition harness.*
   b. Pneumatic tires.*
   c. Oleos.*
   d. Tanks (lubricating oil).*
   e. Electronic equipment.*
   f. Water seals around wheels and other amphibian units.*
12. Bomb bay doors.*
13. Fairing for gun turrets.*
14. Windshield cleaner (power driven wiper or direct air jet).
15. Remote position indicator (transmitter and pressure gage).
16. Transfer pump.
17. Cargo and bomb hoists.
18. Ejector type bilge pump.
19. Instrument drives.*
20. Wing folder.

21. Signal horn.*
22. De-icer boots.*
23. Engine controls.*
24. Floats.
25. Automatic pilot (all pneumatic).*
26. Remote reading pressure gage.
27. Propeller featherers.

Employment of compressed air in all of the foregoing items falls into one of the following classifications of application:

1. Linear motion.
   a. Non-positioning.
   b. Positioning.
   c. Boosting (follow-up positioning with load feel).
2. Rotary motion.
   a. Unidirectional.
   b. Dual rotation.
   c. Positioning.
   d. Boosting.
3. Displacement.
4. Signaling.
5. Direct application of air jets.

It is almost essential that the load-stroke characteristics of an installation be known before the best type of control for the cylinder can be selected. Since cylinders and pistons are generally used for linear motion, let us consider the various means of controlling them. With pneumatic damping or snubbing, two basic types of air cylinders are used:

1. Light air cylinders, where control is such that normally no pressure is applied and cylinder is at atmospheric pressure. When operation is initiated, pressure is applied to one end of cylinder (only until movement is completed), then it is withdrawn. This frequently allows cylinders to be made with little or no packing, without serious leakage, since air pressure is only applied for very short periods.

2. Dense air cylinders, where air pressure is always applied to one side of piston or other. Better cylinder and packing design is required for this type. In some applications, better control of piston movement and/or simpler valving is afforded. When pressure is required to hold piston at either end of its stroke, dense air cylinders are used.

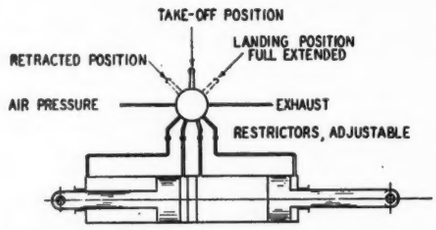


Fig. 19. Diagram of wing flap air cylinder with positive mid-position.

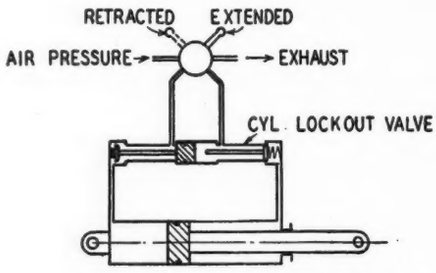


Fig. 20. Sketch showing application of cylinder lockout valve.

To control either of these cylinders, compressed air is *metered* to one end of the cylinder while the exhaust is *metered* out the other end. In the dense air cylinder there is always adequate cushion air to meter out, but with the light air cylinder, where only atmospheric pressure is present on the "down" side of the piston, there is not enough cushion air to meter out to insure smooth operation. This is especially true where fast action, such as opening of bomb bay doors, is desired at high altitudes.

To prevent such condition, some compressed air is put into one end of the cylinder for cushioning, before air is applied to the opposite end for movement. This may be accomplished by using, 1. solenoid valve with automatic delay and reversal, as shown in Fig. 17*a*, 2. manual valving, or 3. automatic pneumatic one-shot snubbing valve as shown in Fig. 17*b*. For movement to the right (see figure), full air pressure is applied at (A), from where it flows unrestricted through valve (R), filling the right end of the cylinder to, say, 100 psi., whereupon it closes and stays closed until *all* pressure is removed. At the same time, air is being metered into the left end of the cylinder through a restrictor. As this pressure increases and the cushion charge in the right side is metered to atmosphere, the piston moves slowly to the right under most load conditions. The air lost in this cushioning charge is negligible.

There are some load conditions where pneumatic cushioning cannot be used. Air cylinders can be built with integral hydraulic (Fig. 18) or mechanical snubbing, widening the scope of application considerably.

The foregoing discussion applies mainly to full-stroke non-positioning applications. Positioning jobs can be handled with air cylinders when there is no tendency to flutter or where the fluttering is sufficiently damped. Here, again, small built-in hydraulic control can be used with the air cylinder for power, where damping is required. A pneumatic motor with reduction and ball bearing jack screw can be used, but usually is heavier and more costly. Special cylinder and control equipment is available in the industrial and marine fields to do this remote positioning with only one interconnecting control air line and an air power supply line. This is being adapted to aircraft work and already is used experimentally for control of multiple engines.

In some cases, a single mid-position is all that is required—as in wing flap

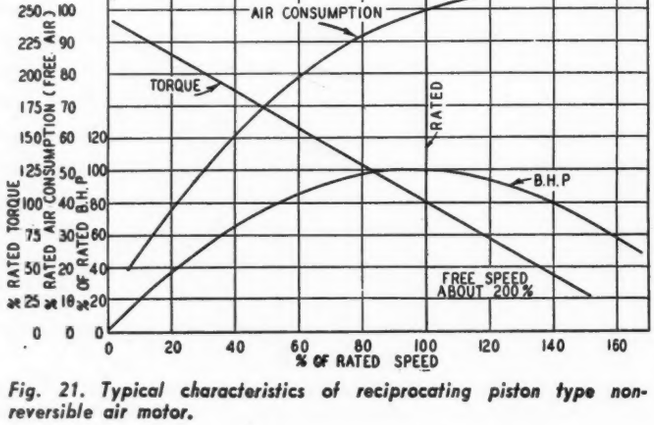


Fig. 21. Typical characteristics of reciprocating piston type non-reversible air motor.

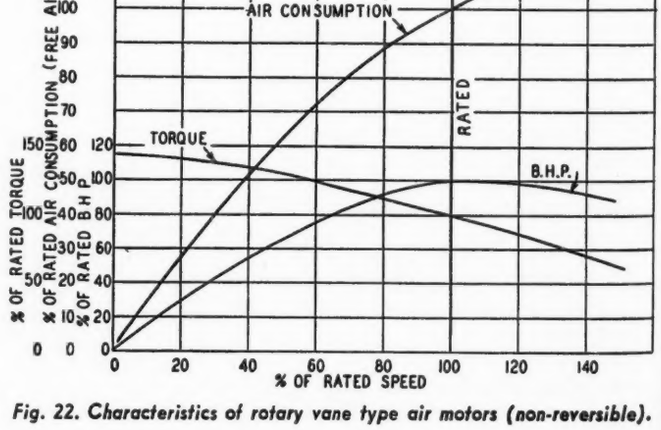


Fig. 22. Characteristics of rotary vane type air motors (non-reversible).

actuating cylinders—and can be accomplished with two cylinders, back-to-back, as shown in Fig. 19. Because the wing flaps must be held both out and in by air pressure, this job inherently requires a denser-air-type cylinder.

An interesting application of a compressed air cylinder is that in a retractable tail-skid or tailwheel installation, wherein compressed air is locked in the cylinder in the extended position and forms the cushion or pneumatic spring. This is done with a lockout valve similar to that used with hydraulics (Fig. 20).

Air Motors

There are four basic types of pneumatic motors: 1. Reciprocating piston—in-line, radial, "V", barrel, and others; 2. rotary vane; 3. turbine—usually impulse type; and 4. gear or lobe.

These units are well-known, hence will not be described here. Typical performance characteristics of the first three types are shown in Figs. 21, 22, and 23. The gear types are not generally used as motors because of leakage and inefficiency. Many types of small air motors are in mass production for hand-held pneumatic tools. These units compare very favorably on a weight basis with other aircraft motors (Fig. 16). Some models may be used for aircraft installations, but not all types are 100% positive starting and others will not run without lubrication; hence, proper selection should be made.

Pneumatically released brakes are frequently applied to air motors and turbines for industrial hoists, and similar equipment could be used for aircraft service if the need arises.

To eliminate the large lines required to handle the exhaust air from a remotely controlled reversible air motor, a small reversing valve, as shown schematically in Fig. 24, may be used. This simple slide valve diverts the exhaust to atmosphere, right at the motor, hence the long air lines need only be large enough to handle the high pressure motive air.

Air Jets

In addition to the obvious displacement uses of air, there are jobs that employ an open air jet because the air is not returned to the system after use. Typical of these is the ejector shown schematically in Fig. 25. Here, air is used as motive power to compress the inlet air or to pump a liquid, such as bilge water. Another use of high velocity air is for cleaning windshields—particularly curved installations where the normal blade wiper cannot operate properly. In this case a small jet of high pressure air is directed over the area to carry away the water and dirt.

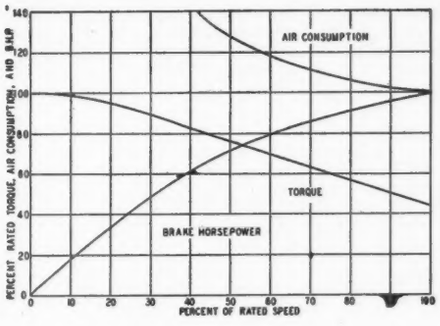


Fig. 23. Characteristics of impulse turbine.

Fluids used to prevent icing can be blown on the windshield, the air blast not being seen by the pilot.

It is desirable to keep a pneumatic system tight, not only to maintain the pressure for the brakes when parked, but also to have as much air available as possible for starting the engines. A pressure-tight system can be achieved with a properly designed system. It should be noted, however, that a leaky system is not hazardous, merely inconvenient. One of the greatest sources of leakage is the valves—unless they embody soft seats, are of the poppet type, and are not perfectly balanced (that is, some seating force is required). Metal-to-metal seated poppets and spool- or sliding-valves have never been made completely pressure-tight on air. Fig. 26 shows the relative amounts of power that can be dissipated through small leaks in pneumatic and hydraulic systems. Obviously no such power loss can be tolerated continuously.

Sliding seals in hydraulic-system valves may be satisfactory, but in a pneumatic system, where there is little or no lubrication, experience indicates that sliding seals cannot be used in closely balanced valves because of eventual stickiness. The present hydraulic valving on the market can only be used satisfactorily for air when it meets the requirements indicated above.

Pressure Reducing Valve

To store pneumatic energy in a receiver, the pressure must be higher than that required by the various devices using air. The greater this permissible pressure drop, the more efficiently the receiver is used. Practical restrictions limit the pressure drop in most cases to ½-⅔ maximum permissible receiver pressure. For example, a system designed for 1,000 psi. maximum storage pressure would have landing gear retraction cylinders that would function satisfactorily on about 600 psi. applied pressure, thus permitting a 400-psi. pressure drop, in the receiver, from which to get power. When a cylinder is designed large enough to function on 400 psi., and full receiver pressure is applied to it, not only is the speed of operation slightly faster but much more air is used than is necessary.

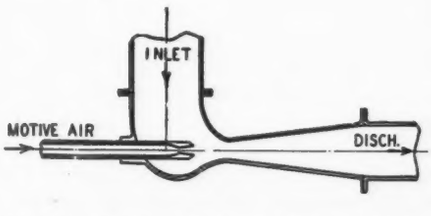


Fig. 25. Diagram of air jet ejector pump.

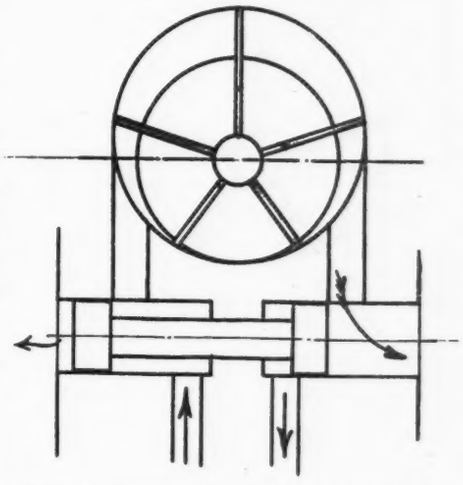


Fig. 24. Diagram of reversing valve for air motor.

This extra air is particularly objectionable when several operations of the cylinder are desired with no compressors in operation, all air coming from the receiver. To conserve this extra air, a simple reducing valve is installed that maintains 450 ±50 psi. downstream. In most applications of this nature,

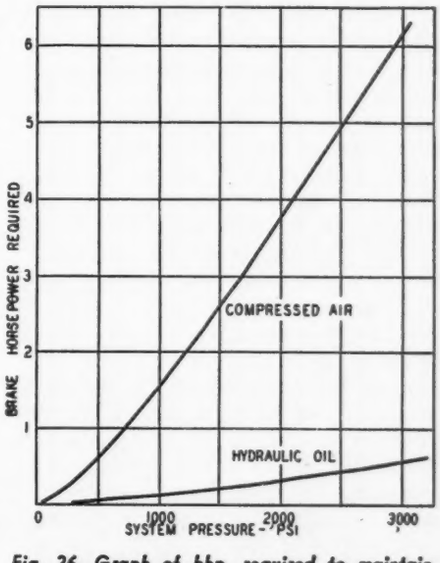


Fig. 26. Graph of bhp. required to maintain leakage through 1/64-in. sharp-edge orifice.

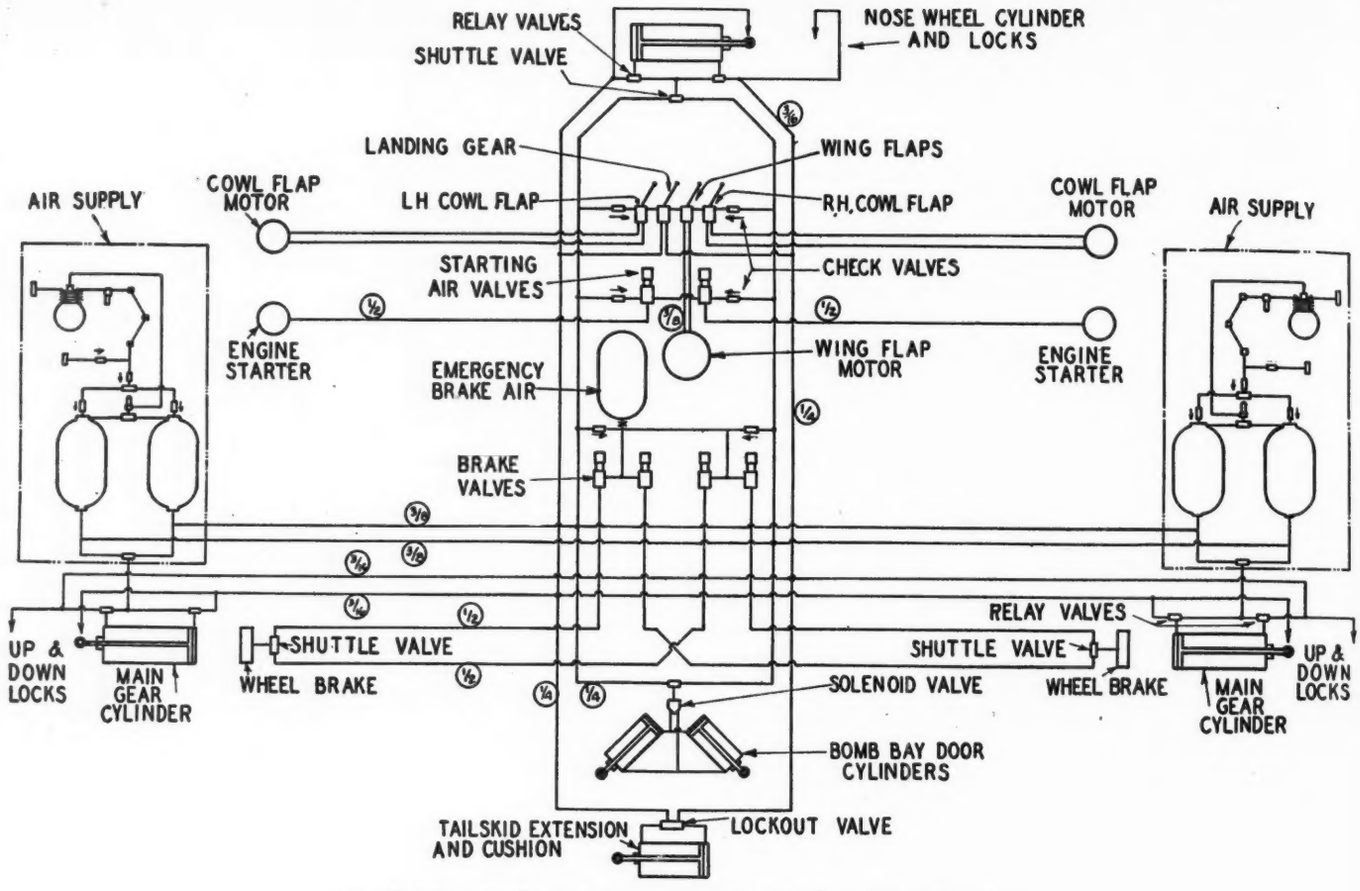


Fig. 27. Schematic diagram of pneumatic system for large-twin-engine plane.

ruggedness, simplicity, and lightness in the valve are more important than accuracy of control. Safety valves should be installed on the downstream side of the valve unless all equipment is designed for full working pressure.

Typical Systems

Fig. 27 shows a pneumatic system layout for a large twin-engine plane. Main lines and receivers are all in duplicate to reduce vulnerability and enhance reliability, and a separate receiver is available for emergency brake application. Either compressor may charge the entire system, or either half of the system. The receiver selection valve will divert flow of air to the intact receiver should the other be damaged, and the latter will automatically be recharged and put into service when it is repaired. In this layout, pneumatic control is carried to the pilot, but solenoid operated valves could be used, if desired, although they are much heavier. Brake valves are provided for both pilot and co-pilot, but it is assumed that the other controls would be on a common control stand. Bomb bay doors are controlled electrically with a solenoid valve. Approximate line sizes are also shown.

The tailskid uses the air in the cylinder not only for extension and retraction but also for cushioning, when extended. This eliminates a heavy and expensive oleo shock-absorber or spring. Manual cowl flap control is shown, although automatic control is easily accomplished.

In contrast, Fig. 28 shows a typical pneumatic system for a small four-place

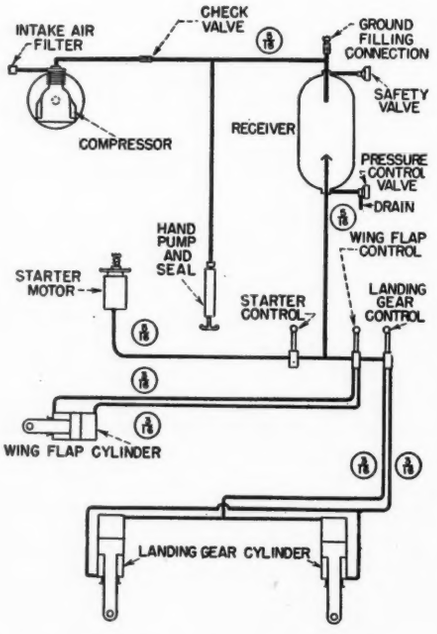


Fig. 28. Schematic diagram of pneumatic system for single-engine personal plane.

175-bhp. single-engine personal plane. Reliability, low cost, and simplicity are imperative here. The system is designed for engine starting, landing gear operation, and wing flap control. Weight is about 40 lb., and cost is below that for competitive methods for doing these jobs.

A ground filling connection is provided so that the receiver may be charged from any tire filling station, and a manual pump is included for an isolated start when air pressure has been spent. Only about 50 psi. is required for a normal temperature start. Normal maximum system pressure is 200-300 psi., since a single stage compressor is used for simplicity.

In all planes—especially small craft—pneumatic power works hand-in-hand with a.c. hi-cycle electric power. Pneumatics are at their best where a.c. systems are not feasible. Conversely, a.c. systems are best for radio work, where air cannot be used. There has been considerable attention given recently to lightplane constant-voltage variable-frequency hi-cycle a.c. systems for reasons of weight-and-cost reduction. Pneumatics complete such a power system.

The several advantages we have here considered—notably that of weight saving—predicate an increasing use of compressed air in aircraft.

Strain Analysis Quickly Finds Formability Limits*

PART II

By **GEORGE GERARD**, *Senior Research Engineer, Republic Aviation Corp.*

Concluding article of this pertinent series, giving application of strain analysis to joggling by means of both formulas and experimental results.

AN EXPERIMENTAL INVESTIGATION of the method for predicting minimum bend radii was made on 0.064 in. Alclad 24ST, Alclad 75ST, and R 301T aluminum alloy specimens.

Bend tests on various width specimens were performed on a power brake in which the radii were varied in 1/32 in. steps. The specimens were bent 90 deg. to different radii close to the minimum, producing fracture in some specimens and satisfactory bends in others. Thus, the minimum bend radius was blanketed by the widths tested. Results are shown on Fig. 9.

Strain-gage length characteristics of the materials used in the bend tests were determined, and they will be noted in Fig. 8 (Part I, page 75 Apr. AVIA-

* Based on paper presented before Society for Experimental Stress Analysis. First installment appeared on page 73 of April AVIATION.

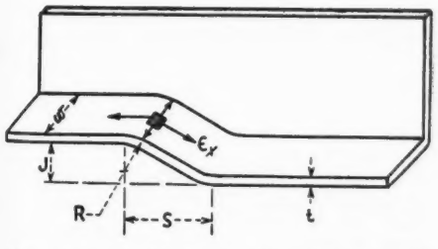


Fig. 10a. Method of determining joggle parameters.

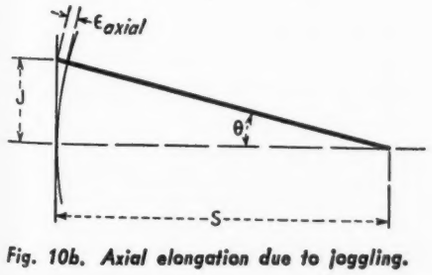


Fig. 10b. Axial elongation due to joggling.

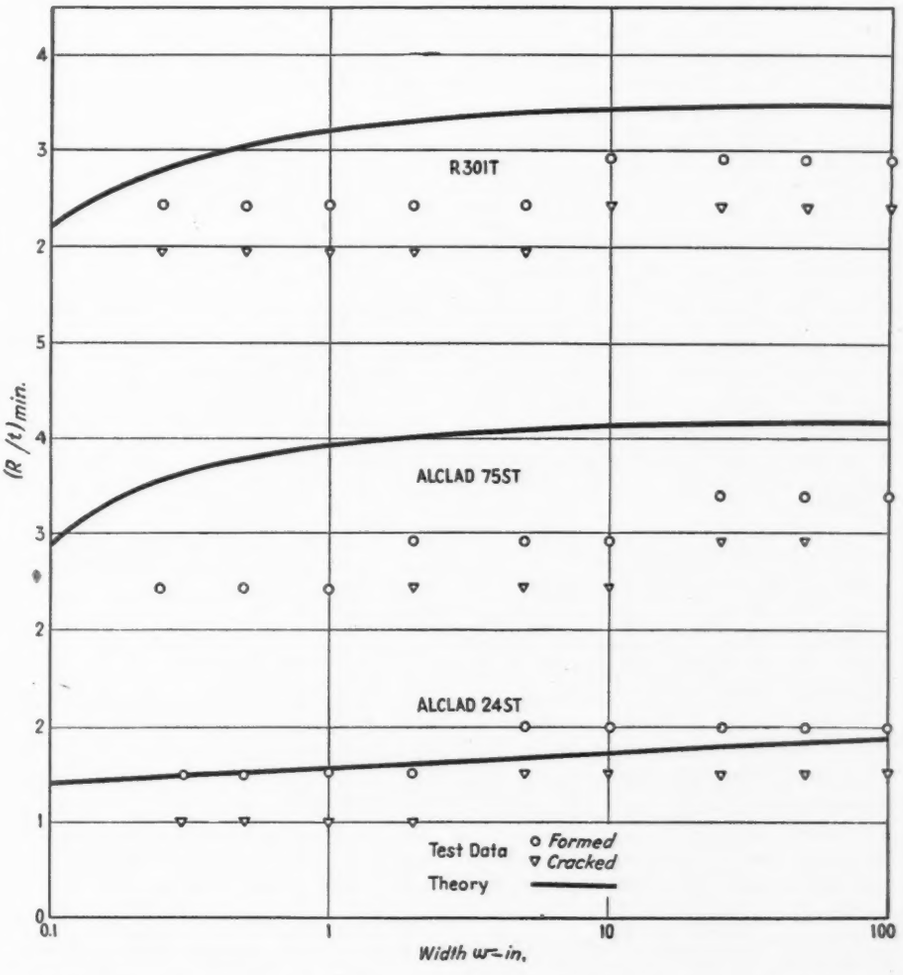


Fig. 9. Agreement between theory and test data on variation of minimum R/t with width.

Experimental and Theoretical Joggling Limits

0.072 in. Alclad 75ST
At Room Temperature

J in.	S in.	Formed in Shop	J/S	ϵ_{Axial} Fig. 11b	$\epsilon_{Bending}$ Fig. 11a $R/t=3.83$	ϵ_t	θ deg. Fig. 11b	L in.	ϵ_{ult}*	Theoretical** Prediction
1/8	3/8	OK	0.333	0.056	0.140	0.196	18.5	0.080	0.203	OK
3/16	3/8	CR	0.500	0.125	0.140	0.265	26.5	0.128	0.182	CR
3/16	1/2	CR	0.375	0.070	0.140	0.210	20.5	0.099	0.196	CR
3/16	5/8	CR	0.300	0.0450	0.140	0.185	16.5	0.080	0.209	OK
3/16	3/4	OK	0.250	0.031	0.140	0.171	14.0	0.068	0.218	OK

* Determined from strain-gage length curve corrected to 1 in. width.
** OK means formed, CR means cracked.
ϵ_t is the theoretical strain required for given joggle dimensions and ϵ_{ult} is maximum strain particular material can sustain without fracture — hence if $\epsilon_t < \epsilon_{ult}$ part will form successfully, $\epsilon_t > \epsilon_{ult}$ part will fracture.

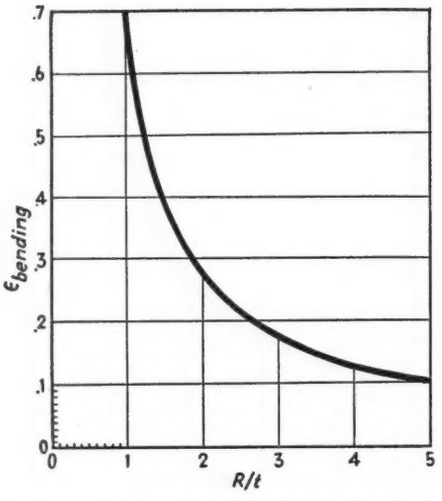


Fig. 11a. Bending strains imposed by joggling.

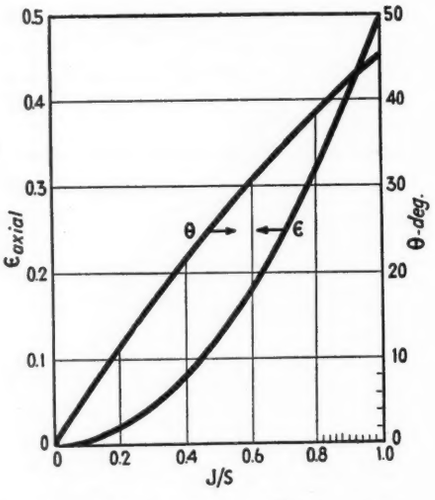


Fig. 11b. Axial strains caused by joggling.

TION). The basic curves, corrected for widths of 1 in. and 100 in., include the correction for the cladding thickness given by Eq. 7 (Part I). These data were then plotted nomographically, as shown in Fig. 6 of our article "Determining Bend Radius—Via Analytical Approach" (page 155 of Mar. 1945 AVIATION). And using this method, minimum bend radii for the different widths were computed.

Test and Theory Check

Theoretically determined radii are presented on Fig. 9 together with experimental data. Agreement of Alclad 24ST data is good, although for the other two alloys the variation of R/t with width as predicted by theory is conservative as compared to test results. In all cases, agreement between test and theory is very good at small width values. The latter points were established from the basic bend analysis and are negligibly affected by the empirical correction established for the width effect. Further study of the width effect may alter Eq. 8 (Part I) so as to bring the width variation of bend radius in closer agreement with test results.

The basic agreement among the results indicates that in spite of the complexities inherent in a theoretical solution of this problem, rational results can be obtained by the methods employed.

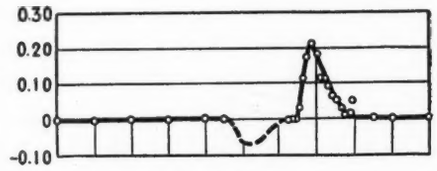


Fig. 12. Strain distribution along center line of 3/16 x 3/8 joggle.

Joggling

A rather interesting application of the strain analysis method is the extension of the minimum bend radius work to the analysis of a joggle based on the assumption that failure will occur at the bend. Furthermore, the strain in the region of curvature is composed of a maximum tensile strain at the outer fiber due to bending, superimposed upon a uniform tensile strain distribution caused by stretching of the metal in the joggle length S in Fig. 10a. Maximum tensile strain from bending is determined as before, with consideration of width effect.

Tensile strains from joggling are assumed to be confined to the joggle length S. Therefore, from Fig. 10b:

$$e = \sqrt{S^2 + J^2} - S$$

The axial strain is obtained by dividing by S

$$\epsilon_{AXIAL} = \sqrt{\frac{S^2 + J^2}{S^2}} - 1 \qquad (11)$$

By use of the binomial expansion, Eq. 11 reduces to

$$\epsilon_{AXIAL} = \frac{1}{2}\left(\frac{J}{S}\right)^2, \qquad (12)$$

when J/S is in the range of joggle dimensions usually employed.

Summing the tensile strains from bending, Eq. 3 (Part I) and axial load, Eq. 12, the maximum tensile strain

$$\epsilon_{ult} = \frac{K}{R/t} + \frac{1}{2}\left(\frac{J}{S}\right)^2. \qquad (13)$$

The joggle angle, θ, is identical to the angle of bend of Eq. 4. From Fig. 10b:

$$\theta = \tan^{-1}\frac{J}{S}. \qquad (14)$$

Figs. 11a and 11b have been prepared to simplify solution of Eqs. 13 and 14. On Fig. 11a, the tensile strain from bending is plotted as a function of the ratio of neutral axis radius to sheet thickness. Fig. 11b depicts the axial tensile strain as a function of the joggle dimensions, J/S. A plot of the angle θ has also been included.

Photogrid Survey

To check the basic assumptions of the analysis, photogrid surveys were made along the centerline of several joggles. A strain distribution along the joggle is shown in Fig. 12. The survey indicated that the forming strains imposed in joggling are confined to the joggle length S and that maximum tensile strains are attained at the bend at which point cracking usually occurs.

Experimental Data

A further check on the analysis was performed by determining joggling limits on some 0.072 in. thick Alclad 75ST "Z" stringers joggled at room temperature. The neutral axis radius of the joggle was 0.276 in. Thus,

$$R/t = \frac{0.276}{0.072} = 3.83.$$

Results of the shop joggling tests and those predicted by the analysis are presented in the accompanying table.

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2. Jackman, K. R., "Super-Aluminum Alloys for Aircraft Structures", Aug., Sept., and Oct. 1943 AVIATION.
3. Gerard, G., "Determining Bend Radius —Via Analytical Approach", Mar. 1945 AVIATION.

Controllable Lightplane Prop Is Easily Adjusted and Serviced

Specifically designed for the lower horsepower range, Continental's new two-position Skypower airscrew is readily installed without use of special equipment. Here, the simplicity of its operation and of its maintenance is carefully detailed.

WITH THE ADVENT of higher wing loadings in the personal plane field, aircraft propeller designers saw realization of notable takeoff, climb, and cruising economies through use of controllable pitch propellers in place of the solid ones formerly fitted. Latest of this type is the Skypower propeller made by Continental Aviation & Engineering Corp., Muskegon, Mich. This unit is for firm's 65–85 hp. engines.

There is a natural desire to maintain comparatively low prices for single-engine lightplanes, hence use of a propeller of the more complex type, such as used on the larger multi-engine aircraft, has not been considered, for it would represent a cost too high in proportion to the total. Therefore, a simpler-form airscrew was sought.

The propeller here described is actuated by two stationary expansion chambers—shown at (4) and (5) in Fig. 1—either of which can be connected to, and extended by, oil from the engine lubrication system, while oil is withdrawn from the other chamber. Between these is a stationary disk attached by a ball bearing to a sleeve which is linked to the rotatable blades. By moving a simple four-way valve, the pilot can direct oil pressure into whichever expansion chamber he desires, thereby rotating the blades into high or low pitch. Because there are no rotating oil joints or seals, positive action is assured and danger of leakage is absent.

Referring to the details in Fig. 1: Rotating blades (1) are carried on ball

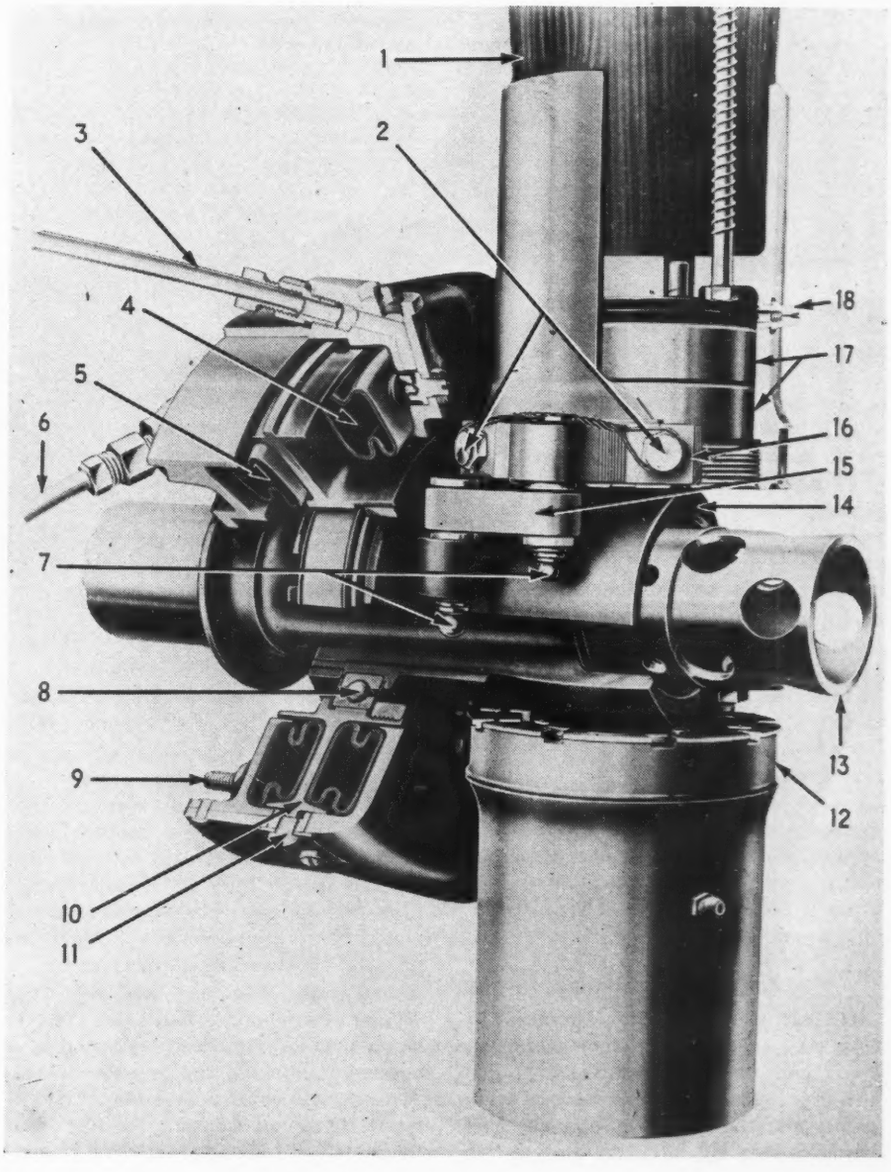


Fig. 1. Cutaway view of Skypower two-position controllable-pitch propeller, showing (1) laminated birch blade, (2) blade angle adjusting capscrews, (3) low pitch oil line, (4) low pitch actuator, (5) high pitch actuator, (6) high pitch oil line, (7) linkage pins and grease fittings, (8) actuator ball thrust bearing, (9) mounting stud, (10) actuator stationary disk, (11) high and low pitch actuator stops, (12) blade ferrule, (13) hub nut, (14) hub, (15) link, (16) altitude adjustment, (17) renewable ball bearings, and (18) ferrule grease fitting.

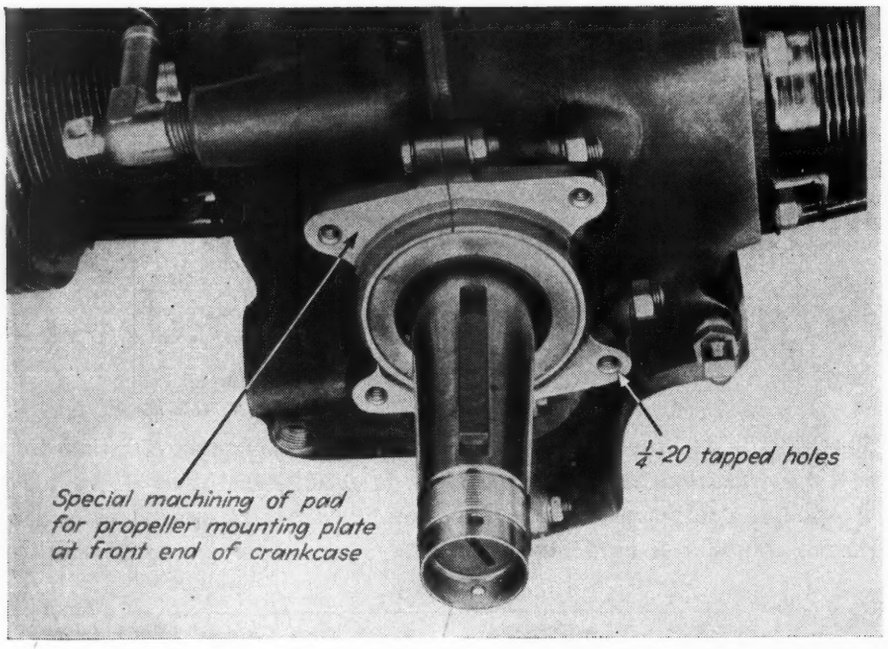


Fig. 2. On older models of Continental engines, special machining was required for fitting propeller brackets. At upper left is breather fitted with elbow for oil return from actuators, while at lower right is straight reducer and elbow for pressure connection from engine oiling system to four-way valve.

bearings (17) which may be renewed without removing blade from ferrule (12). On circumference of ferrule is adjustable fixture (15) which transmits motion to the blade. The position on the blade of these fixtures may be changed—while stationary—to make high and low pitch positions of the blades conform to the requirements for the varying atmospheric conditions obtaining at different airport altitudes.

Connected to an arm on each ferrule is link (15) which rotates the blades when transfer unit (10) is moved back and forth by expansion of either low pitch actuator (5) or high pitch actuator, (4), which are connected by their respective oil lines (6) and (3) to the engine oil system. Motion of actuator (10) is transmitted through ball thrust bearing (8) to a collar which slides on outside of hub and is attached to one end of each link (15) controlling blade rotation.

From the foregoing it will be seen that the entire oil system is closed and has no wearing parts, with the exception of the slight motion of the actuator against the casing, a movement which occures only at the time when blade pitch is changed, the total travel being only a fraction of an inch.

Propeller Installation

On earlier Continental engines it is necessary (see Fig. 2) to machine the front end of the crankcase and drill and tap four ¼-20 holes for capscrews which hold the mounting plate bracket. Tapered bore of hub and mating surface of shaft are then given an even, light coating of clean grease, after which the propeller assembly is placed on the shaft, care being taken to align the key and keyway. In this operation it is essential that the oil connection—shown at (12) Fig. 3—be on top.

Entire assembly is then slid back until the hub nut—(13) in Fig. 1—can be engaged. While doing this, the four supporting studs—(9) in Fig. 1—are aligned with the corresponding holes in the brackets. The hub nut is then tightened with a round bar, and nuts are placed on mounting plate studs. At this point the machined pilot-face of the mounting plate should be checked to make sure that it fits squarely against the machined face of the crankcase.

Control Valve and Oil Lines

For installation of control valve and oil lines refer to Fig. 3. Four-way valve and its bracket assembly is mounted on top of engine at (5), being secured by crankcase bolt (9). Two pipe plugs at (11) and (12) are removed, and straight tube connectors (supplied with propeller) are inserted in the openings. All threads on these and other connections should receive an application of non-hardening oil-resistant sealing compound. The two end threads on all internal joints should be kept free from sealing compound, because this material has a tendency to creep while the joint is being tightened, and any excess compound would enter the engine-oiling system. Being oil-resistant, sealing compound will spread upon and clog screens.

The pipe plugs are of no further use until the unit is disassembled at a future date, when they should be used in their original positions to prevent entrance of dirt. This precaution also applies to the four protector plugs removed from the four-way valve, at (3), (4), (6), and (7) to permit installation of straight tube connectors, this being the next step.

Remove pipe plug from front crankcase left side oil header at (11) and install the ⅜ to ⅛ reducer bushing and connector elbow provided with propeller.

Next remove breather elbow (15) and drill and tap ⅛ pipe thread at (16), then replace. Connect four oil lines in following order: Constant pressure line (10) from crankcase at (11) to valve at (6); alternating pressure line (8) between valve at (7) and actuator at (12); line (14)—carrying alternating pressure—from valve at (3) to actuator at (13); and drain line (1) which returns oil from valve at (4) to breather (15). In applying sealing compound to these eight joints, same methods and precautions should be used as were indicated for installing pipe connections.

Control cable and bracket are then installed, bracket being held by crankcase bolt, with eye on bracket turned toward case. Drill ⅜ hole through instrument board and firewall and assemble control cable through the hole. Clamp tubular cable jacket in clip and connect wire to four-way valve at (2), first pushing knob on instrument panel inward until it touches surface of panel, also moving control lever on valve to full forward position. Under these conditions, blades will assume low pitch position when, later, oil pressure is applied by running engine.

Inspection and Checking

With propeller control set in low pitch position by pushing knob on instrument board forward as far as it will go, start engine and check all tube connections for tightness. Any leakage can be better observed if all joints have been wiped clean before starting. If leakage appears at tube connections, they may be tightened cautiously, but if any oil seepage appears around points where connections have been screwed into the crankcase or valve body, the pipe joints must be loosened before these parts are further tightened. It should be remembered at all times that pipe fittings, though amply strong for the work they have to do, are easily broken by application of too much force when tightening. In many cases the damage will be in the form of invisible cracks, which become permanent leaks as soon as oil pressure is applied, grounding the plane until these fittings are replaced.

With wheels blocked, run engine at

full throttle and check rpm. on tachometer, comparing this speed with take-off rpm. specified by manufacturer. It should be remembered that a two-position propeller, when running on the ground in low pitch, will impose a slightly greater load on the engine when in climb or level flight and, therefore, engine rpm. will be lower on the ground than when in the air. Consequently, ground rpm. of prop should be adjusted to permit maximum engine speed in climb, otherwise if propeller is adjusted on the ground for maximum speed there will be danger of excessive rpm. in flight.

To accomplish this adjustment to give best possible flight results, it may be necessary to make several short test flights. If rpm. is too high or too low, blade angle should be changed until speed is correct.

One degree of change in pitch angle will change speed approximately 90 rpm. This fact greatly simplifies blade angle adjustment, because angle of change can be figured by dividing 90 into the difference between actual and desired rpm.

Angle of blade is measured by means of a bubble protractor or inclinometer, using the following methed: (a) Turn propeller to horizontal position, (b) place blade in low pitch position, and (c) hold protractor against blade at reference line marked on driving face at edge of plastic coating, making a record of reading. To guard against false readings because of position of plane on ground, turn second blade, before measuring, into position occupied by first one when its angle was measured. For instance, if blade No. 1 was measured on the right hand side of plane, then the second blade should also be measured in that position.

To change pitch angle, set protractor to angle required, then remove lock-wire from capscrews—(2) in Fig. 1—which hold link fitting (16) to ferrule. Loosen capscrews and turn blade to correct angle, checking with protractor on reference line.

Turn propeller half a revolution to bring second blade into same position and repeat blade adjustment, also checking this blade with protractor. Tighten cap-screws with torque wrench to 60–70 in.-lb. Then check angle of both blades again with protractor and, if correct, lockwire the capscrews. It is essential, for balance, and therefore flying efficiency, that the angle of both blades should be *exactly* alike. Compensation for operation at higher altitudes is also made in this manner.

Lubrication

"Lubriplate" ball bearing grease, or its equivalent, should be used for lubricating this propeller. Requiring attention are: One point on each blade ferrule, four on linkage pins, and one on actuating unit. Ferrule fittings need no attention between overhauls, but others should be greased every 25 flight-hours. New propellers are completely lubricated before shipping, hence require no further servicing before installation.

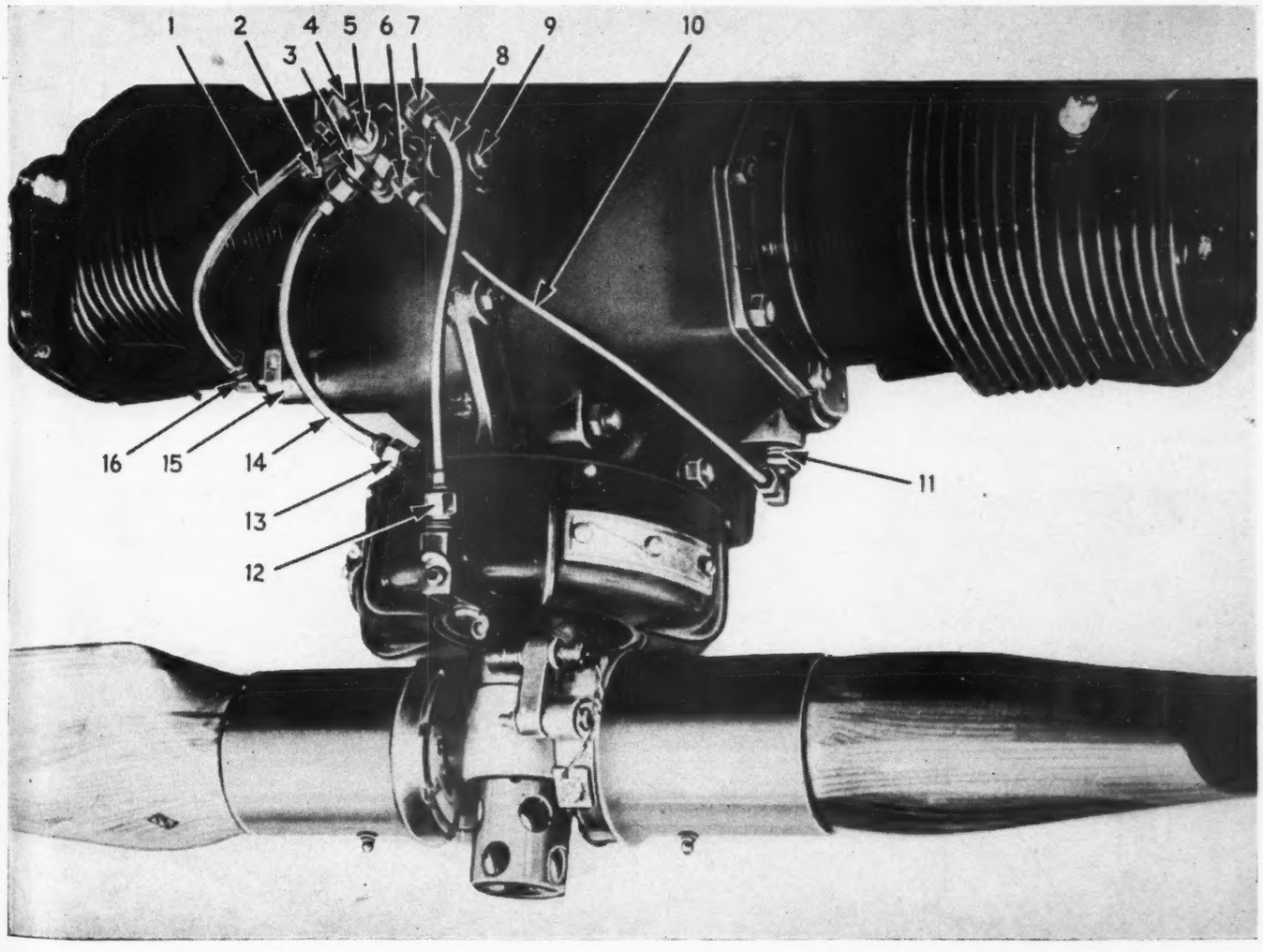
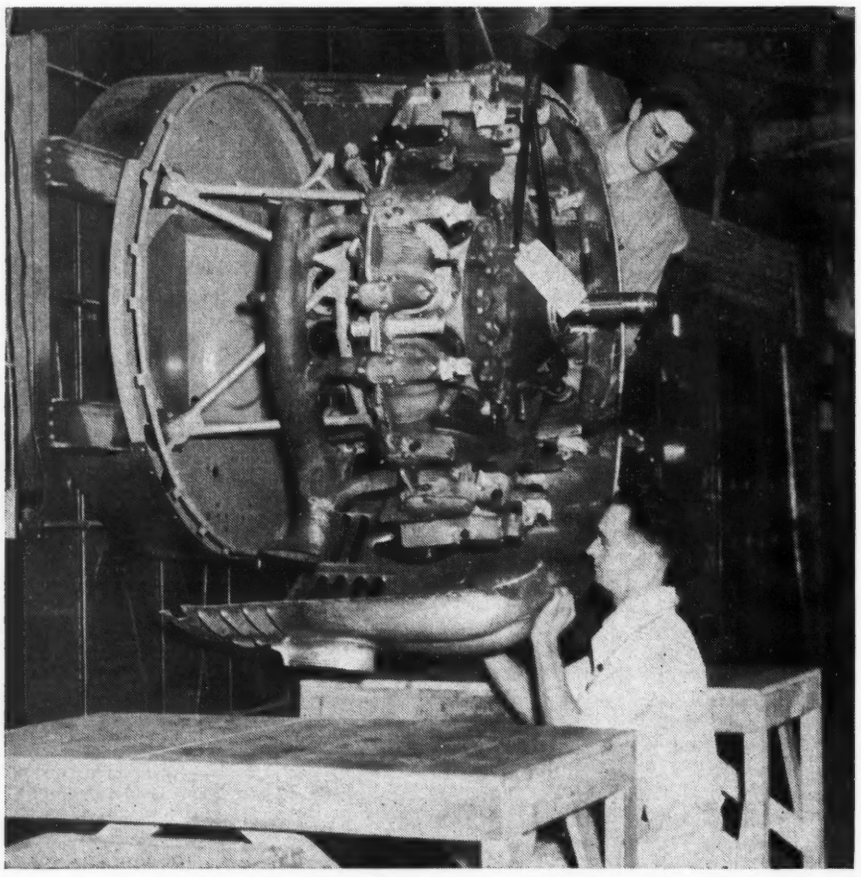


Fig. 3. Four-way valve and plumbing, showing (1) oil return to breather, (2) control lever and wire, (3) high pitch actuator fluctuating pressure line, (4) attachment for line (1), (5) four-way valve, (6) attachmemnt for line (10), (7) attachment for (8) fluctuating pressure low pitch oil line, (9) crankcase bolt holding four-way valve, (10) constant pressure oil line from engine oil system, (11) fitting which connects (10) to engine oil system, (12) low pitch actuator oil line connection, (13) high pitch actuator oil line connection, (14) high pitch actuator oil line, (15) crankcase breather to which is fitted elbow (16) for oil return from four-way valve.

AVIATION'S MAINTENANCE NOTEBOOK



Power Plant Mockup Expedites Cowl Fitting

• Using old engine mount together with engine built from discarded parts, AAA has eliminated misfits in making cowling replacements. Because dimensions of mockup conform exactly to those on its airplanes, renewal cowls always fit without trouble.

Special Paint Rack Keeps Floor Clear

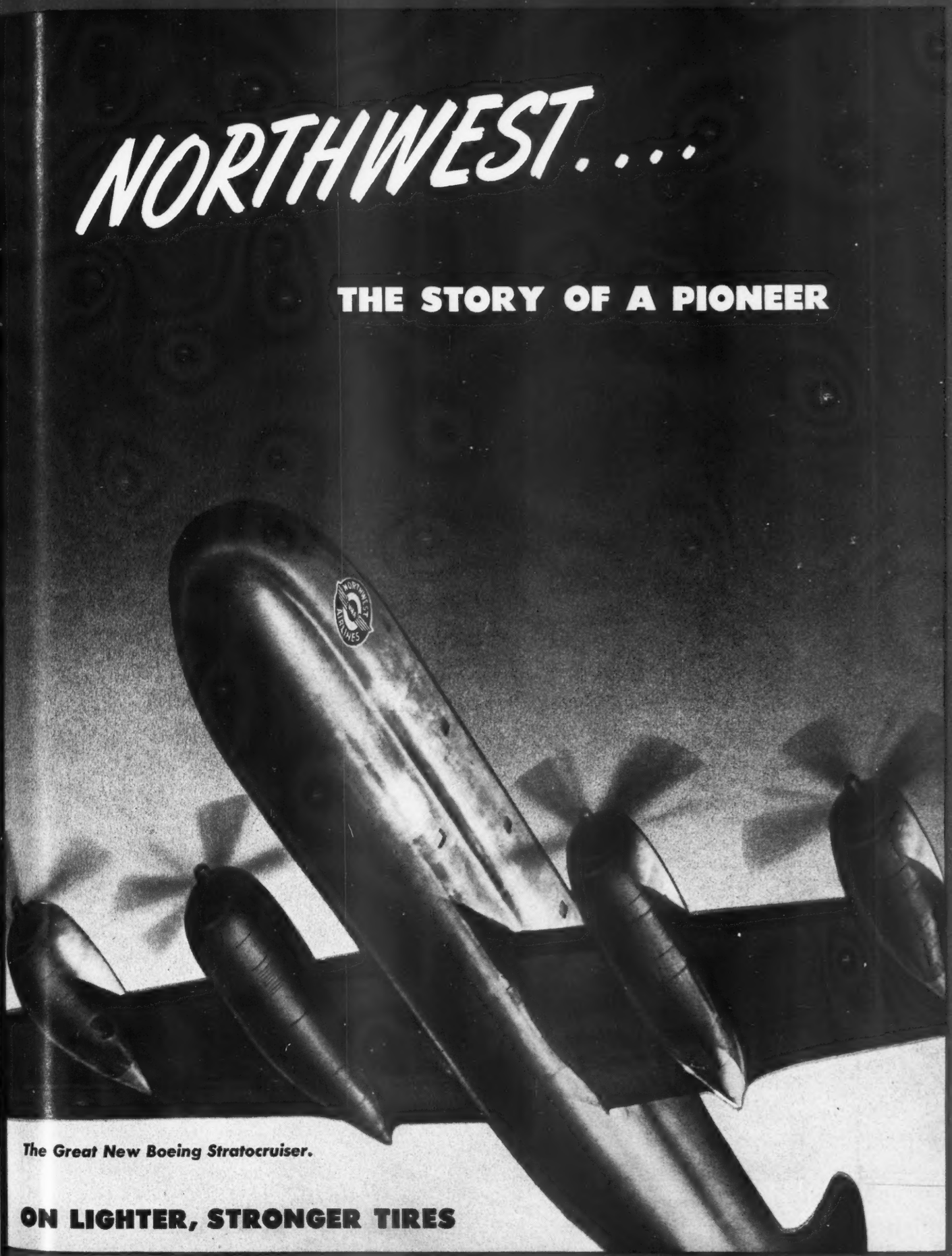
• Eliminating any untidy accumulation on shop floor of partly used paint containers, this rack enables mechanics at C. K. Grieder's Martin's Creek Airport, Pa., to locate instantly any required finishing materials. Numbered sections permit easy segregation of items.

Tie-Down Fixture Stormproofs Cubs

• Welded together from odd pieces, this tail support is used at Piper's Cub Haven Airport, Lock Haven, Pa. Theory that planes will not blow around if wing is tilted at negative angle, is proved correct in practice. Tailwheel spring rests on, and is fastened into, top of support.

NORTHWEST....

THE STORY OF A PIONEER



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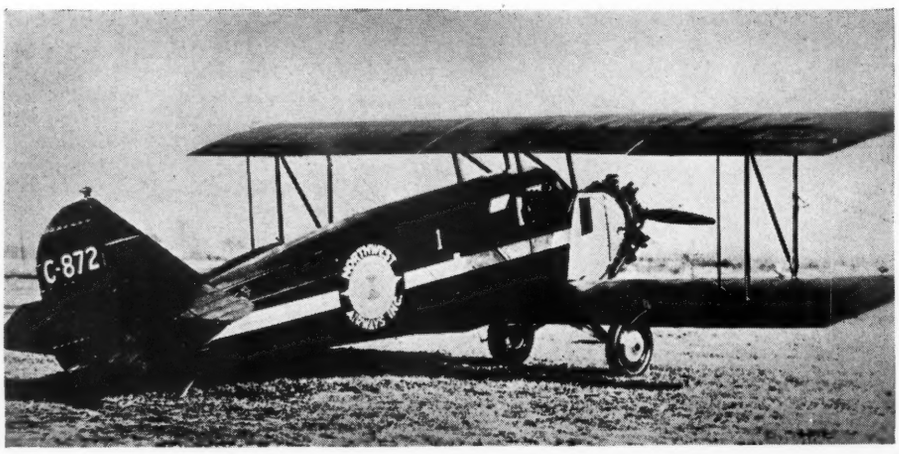
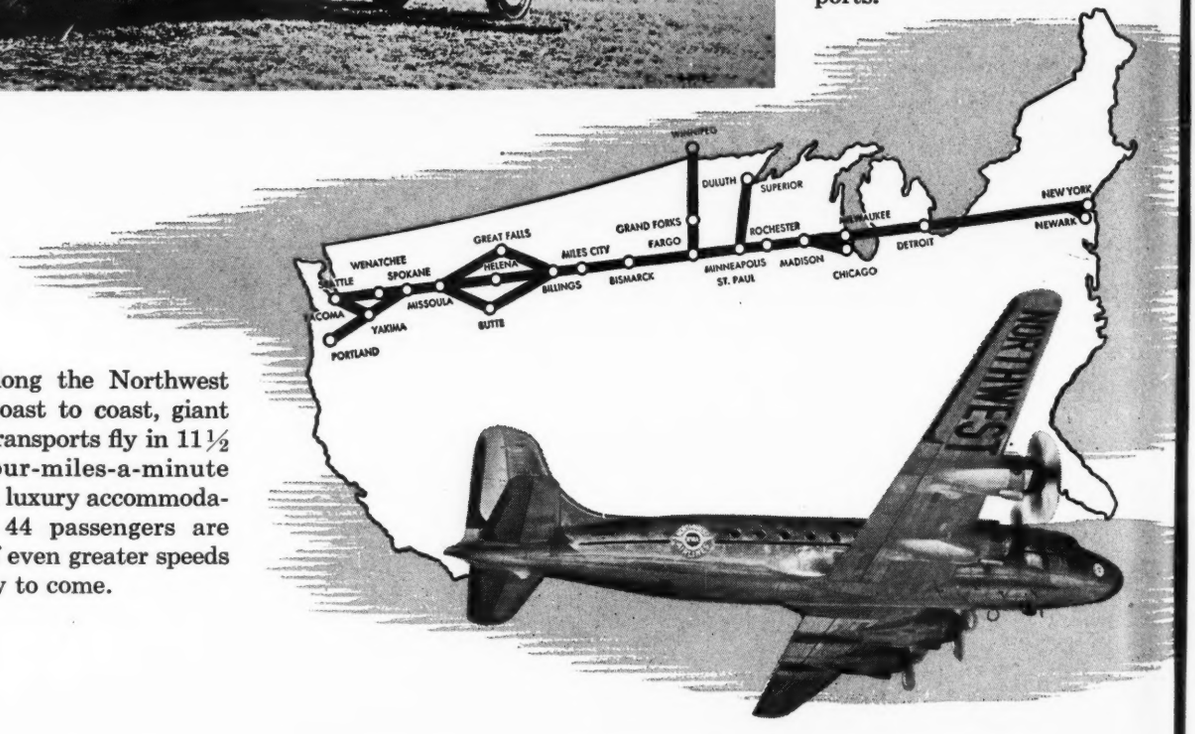
20 YEARS OVER THE NORTHWEST PASSAGE

MAKES NORTHWEST



1926 One of the three Stinson-Detroiter cabin planes which flew the mail on Northwest Airway's route between Minneapolis and Chicago. Averaging 70 pounds of mail to the round trip, these planes, pioneers all, were the forerunners of today's luxurious transports.



1946 Along the Northwest Passage, coast to coast, giant 4-engine transports fly in 11½ hours. Four-miles-a-minute speed, and luxury accommodations for 44 passengers are samples of even greater speeds and luxury to come.

Vacationists everywhere look to Northwest Airlines to prolong holidays spent on the range, at dude ranches, in hunting or fishing.

UNITED STATES

THE NATION'S SECOND OLDEST AIRLINE!

1947 Tomorrow's Northwest Airliners will begin service early in 1947. Already purchased, ten of these giant 80 passenger Boeing Stratocruisers are being built for swift 340 miles-an-hour transcontinental service. And Northwest has applied for certification to send these big ships clear to the Orient.

Eighty passengers will ride in lounge chair comfort high above the weather in the pressurized Boeing Stratocruiser. The upper deck is shown above; below it, a spiral stairway leads to a smart cocktail lounge that easily accommodates 14 persons.

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R. I. FIRM DEVELOPS TWO NEW UTILITY 'COPTERS

Helicopter Engineering & Construction Corp. is building one-placer, to have 100-mph. top speed with 75-hp. Continental. Also scheduled is two-seater of similar layout. These craft, aimed at low-price field, are planned for simplicity of operation.

DESIGNED FOR LOW-COST, utility, and ease of operation two new small helicopters are under development by Helicopter Engineering & Construction Corp., of 2735 Pawtucket Ave., East Providence 14, R. I. Model 100, slated to be a single-placer, is now being built at Allen School of Aero at the state airport, Hillsgrove. And Model 101, intended to seat two, will be very similar in layout to its predecessor.

Flight tests of Model 100, which is to have a 200-lb. baggage capacity, are expected to start in about two months. The craft will have a steel tube fuselage, covered with light plywood skin and fabric. A Continental A-75-9 engine of 75 hp. at 2,300 rpm. will be mounted just behind the cabin. A fixed tricycle landing gear is to be utilized.

Radius of the three-blade main rotor is given as 9.75 ft., while power loading is put at 10 lb./hp. and disk loading at 2.5 lb./hp. A tip speed of 400 fps. is given, while solidity ratio is to be .06. Anti-torque rotor is to be of 2.25-ft. radius.

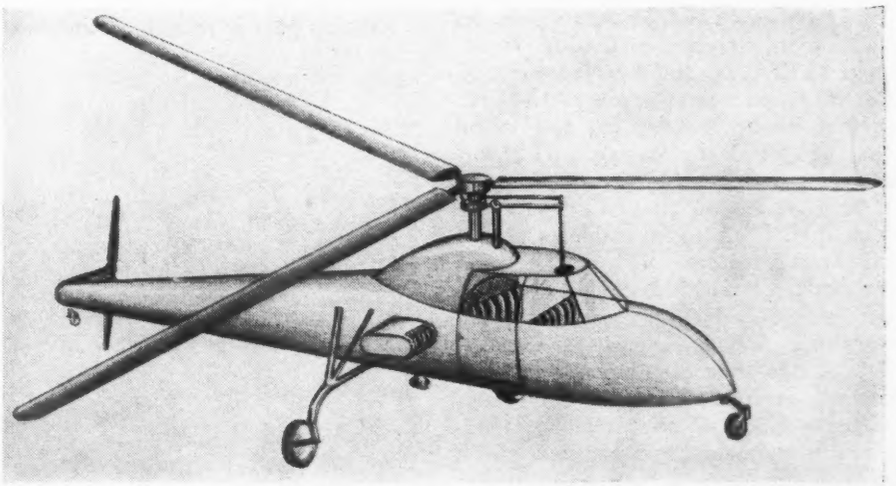
Model 100 Performance

A top speed of 100 mph. is contemplated for Model 100, which is to have a gross weight of 750 lb. and an empty weight of 350 lb. Maximum rate of climb is planned at 1,200 fpm., while maximum vertical rate of climb is to be 650 fpm. Descent velocity during autorotation along the flight path is given as 1,800 fpm.

Components for Model 101 have been designed to be similar to those of the earlier craft. However, fuselage and transmission will vary slightly in that different placement of the main rotor gear box is necessary to provide accommodation for the passenger, who is to be seated at the C.G.

Utility seen by the company for the one-placer includes its use by salesmen and for mail delivery from post office to airport. A price of about $2,000 is under consideration.

Single-place Model 100, to have 200-lb. baggage capacity, is designed for use by salesmen or for mail pickup work. Main rotor is to be of 19 ft. 6 in. dia., while tail anti-torque rotor will have 4 ft. 6 in. dia. (Aviation sketches)



Model 101, planned as a two-seater, is to be basically similar to smaller model 100 'copter. Addition of passenger has dictated several modifications, such as different placement of main rotor gear box and some redesign of cabin.

Craft's all-cantilever design is pointed up in this view, as is wide degree of visibility from coupe type cockpit enclosure. Gross weight is 1,675 lb., useful load is 585 lb., and baggage capacity is put at 50 lb.

Meyers Grooming Fast New Two-Placer

Wing slots and retractable landing gear utilized on low-wing craft that has stated 140-mph. top speed.

ANOTHER NEWCOMER in the personal plane field is the Meyers MAC 125-C, a side-by-side two-seater made by Meyers Aircraft Corp., Box 721, Tecumseh, Mich. The firm reports a high top speed and good cruising range for the new craft, which is now being put through its paces for an Approved Type Certificate.

Powered by a 125-hp. Continental C-125 engine, placarded top speed is given as 140 mph., cruising speed as 120 mph., and stalling speed with flaps as 45 mph. Climb from sea level for the first minute is stated to be 700 ft., and maximum range with 30 gal. of fuel is 500 mi.

Span is 30 ft., length 20 ft. 10 in., and overall height 8 ft. 6 in. Wing area is 149 sq. ft., including ailerons. Areas of other surfaces are as follows: Ailerons 5.38 sq. ft., rudder 3.69 sq. ft., fin 5.33 sq. ft., elevators 8.84 sq. ft., stabilizers 13.15 sq. ft., and flaps are each 6.67 sq. ft. Gross weight is put at 1.675 lb., weight empty is 1,090 lb., and useful load 585 lb. Wing loading is 11.24 lb./sq. ft., and power loading is 13.4 lb./hp.

Fuselage is of all-metal monocoque construction. A roomy cabin is one of the craft's features, with entrance and exit gained through hinged panels (split at the roof) which swing outward and forward. Baggage capacity is given as 50 lb. Instrumentation includes altimeter, compass, airspeed indicator, tachometer, and oil pressure, oil temperature, fuel pressure, and fuel tank gages, also an ammeter. A Delco-Remy starter and Reading battery are used.

Wings and all other surfaces are of metal construction, including covering. Fitted in the wings are built-in slots (near the leading edges) and split-type slotted flaps. An NACA 23015 airfoil is utilized at the wing roots, and an NACA 23009 section at the tips. Controllable trimming tabs are fitted to the elevators, while the rudder has a ground-adjustable tab.

Landing gear is retractable and has a 115-in. tread. Hayes wheels have 6.00x6 tires. Hydraulic brakes are utilized, as are spring-oil shock absorbers.

No price for the MAC 125-C has been mentioned by the company, nor have any plans for production. At present, the oncern is engaged in building a number of Dart personal planes for Applegate & Weyant Engineering Corp.

Meyers Aircraft MAC 125-C, powered by a 125-hp. Continental, is an all-metal side-by-sider designed for a 140-mph. top speed and 500-mi. range. Main landing gear retracts inward into wells at wing roots.

FRENCH S.O.-30R BELLATRIX IS SWIFT NEW AIRLINER

Pressure cabin featured in twin-engine medium-range craft, along with tricycle landing gear and reversible pitch props. As sleeper, top speed is given as 338 mph.; with normal seating, 273 mph.

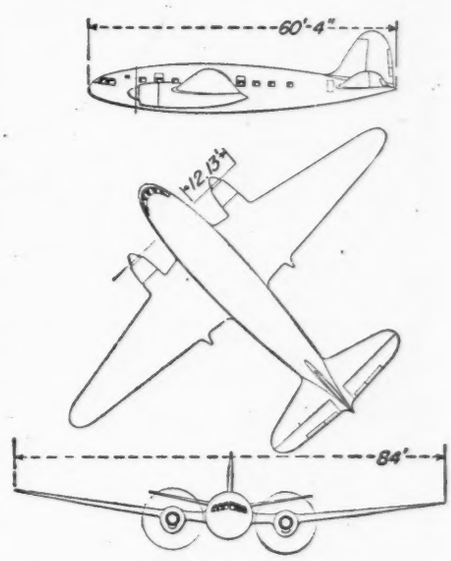
EMBODYING MANY of the latest trends in airliner design, the S.O.-30R Bellatrix is a twin-engined high-performance 16-30 passenger transport manufactured by France's nationalized Societe Nationale de Constructions Aeronautiques du Sud-Oest.

Fuselage is an all-metal semi-monocoque structure of circular cross-section, the cockpit windows being smoothly faired into the unbroken nose line. Rubber sealing is utilized, and it's stated that an internal pressure equivalent to 8,200 ft. can be maintained when the craft is flying at 19,680 ft. The cabin, divided into three sections, can be arranged to seat 30 or be fitted with 16 berths. A bar and a toilet compartment are situated near the tail. Freight is carried beneath the cabin floor and in a compartment built in each inner wing.

A crew of four is specified. Dual controls are fitted, and instrumentation is in duplicate. Electrical instruments are in the center of the control panel. Included is a three-phase automatic pilot. The flight engineer is seated to the left behind the pilots, and the radio operator on the right. Indirect lighting is utilized.

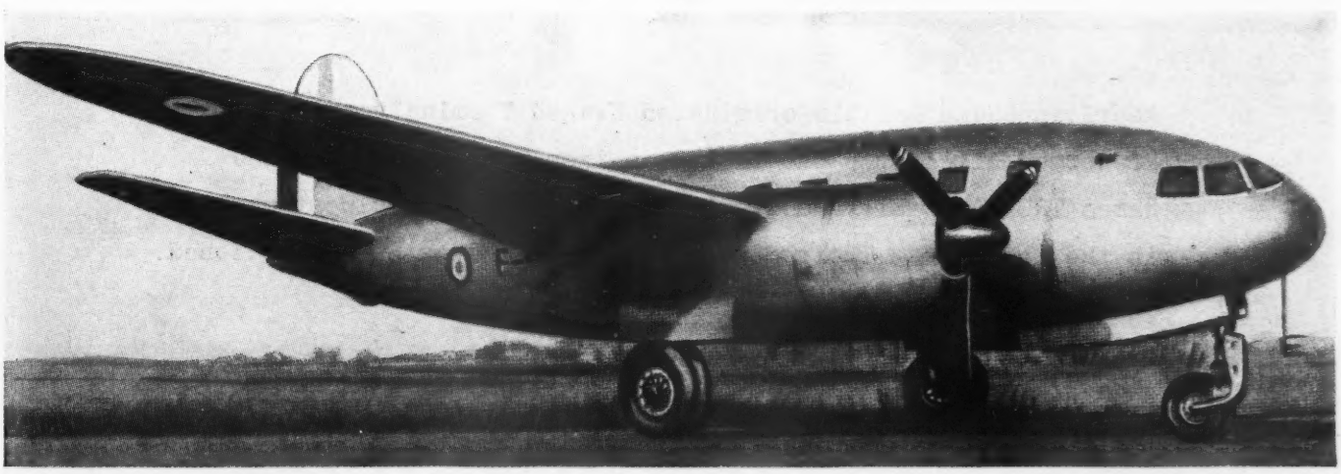
Power plants are 14-cyl. Gnome & Rhone 14R-5s delivering 1,700 hp. at takeoff and 1,295 hp. normally, and they are fitted as quickly detachable power eggs. Electrically controlled reversible-pitch three-blade Ratier props of 12.13-ft. dia. have large spinners which extend into the engine cowls. A 24v. electrical system is used. Landing gear is retractable tricycle, hydraulically operated, and the nose wheel is steerable.

Each wing, of all-metal construction including covering, is made in two sections and has two spars. Fuel tanks, with a capacity of approximately 1,000 gal., are located in the outer wings. Tail surfaces are also all-metal, and the elevators and stabilizers are characterized by sharp dihedral.



Specifications and Data

Span	84 ft.
Length	60 ft. 4 in.
Height	19 ft. 4 in.
Wing area	882 sq. ft.
Gross weight (30 pass.)	36,080 lb.
Empty weight (30 pass.)	21,714 lb.
Top speed at sea level (30 pass.)	270 mph.
Top speed at 25,256 ft. (16 pass.)	338 mph.
Cruising speed at 19,680 ft. (30 pass.)	273 mph.
Service ceiling (30 pass.)	26,732 ft.
Range	621-1,863 mi.
Fuel capacity	about 1,000 gal.
Seating	16-30
Power plants (2)	1,700-hp. Gnome & Rhone 14R-5



Powered by two 1,700-hp. Gnome & Rhone engines, new S.O.-30R transport can carry 16-30 passengers at estimated top speeds of 270 to 338 mph., depending on seating. Craft was designed during Nazi occupation.

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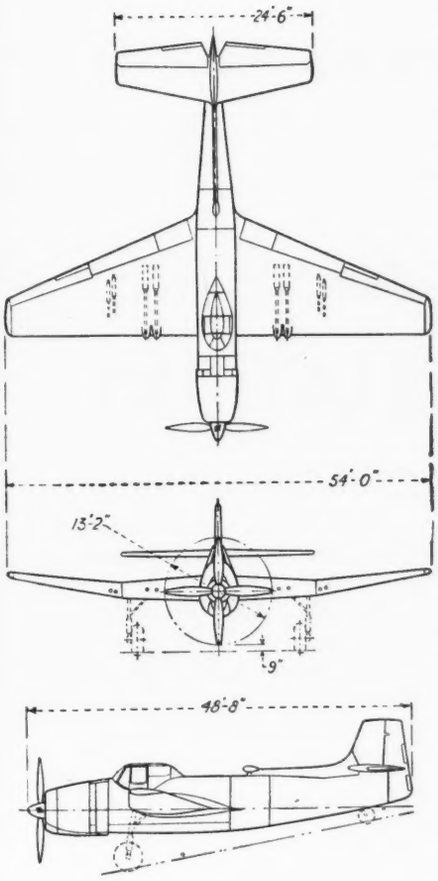
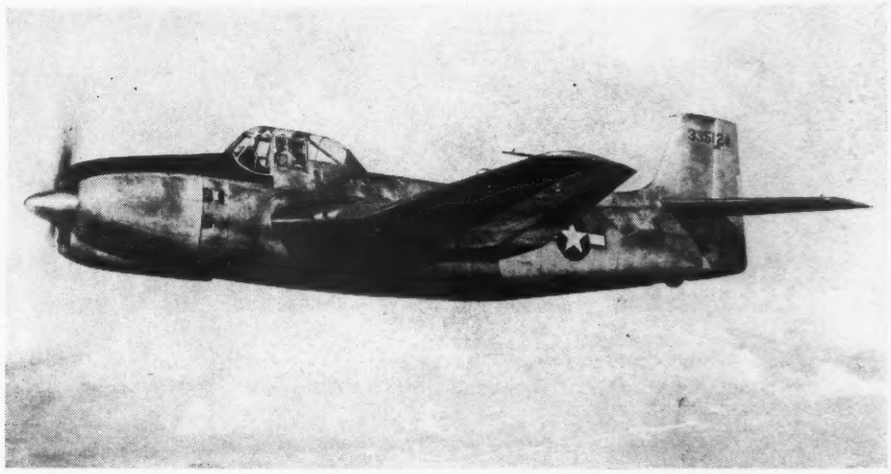
Heavily Gunned XA-41 Was Groomed as Ground Strafer

Though its production was superseded by a JP project, formidable Convair craft for AAF presents prime fighting and bombing capacities which are of marked interest in field of military design.





All-metal Convair XA-41 was designed as a single-seat attack plane powered by a P&W R-4360 Wasp Major of over 3,000 hp. Craft's top speed is reported as 363 mph. and its combat range as 800 mi. Armament was specified as four 37-mm. cannon and four .50-cal. guns in wings. Bomb load of 6,400 lb. could be carried in fuselage. Note unusual cockpit enclosure.

Specifications and Data

Span	54 ft.
Length	48 ft. 8 in.
Height	13 ft. 11 in.
Wing area	544 sq. ft.
Aspect ratio	5.4
Gross weight	24,188 lb.
Maximum useful load	10,852 lb.
Empty weight	13,336 lb.
Top speed	363 mph.
Cruising speed	296 mph.
Stalling speed	74 mph.
Takeoff distance	1,500 ft.
Combat range	800 mi.
Normal fuel capacity	350 gal.
Service ceiling	29,300 ft.
Seating	1
Power plant	3,000-hp.-plus P&W R-4360

DEVELOPED in the latter stages of the war to give close aviation support to our attacking ground forces, the very heavily armed Convair XA-41 never reached the production line, all available facilities being assigned to the company's new XP-81 jet fighter (described on page 95 Mar. AVIATION). Nevertheless, features of the plane are notable.

A single-place midwing monoplane, with conventional retractable landing gear, the XA-41 is entirely of metal construction. Powered by a 3,000-hp.-plus P&W R-4360 Wasp Major, a top speed of 363 mph. is claimed, while cruising speed is stated to be 296 mph. and stalling speed 74 mph. With normal fuel capacity of 350 gal., combat range is put at 800 mi. Span is 54 ft., length 48 ft. 8 in., and height 13 ft. 11 in. Gross weight is given as 24,188 lb. and weight empty 10,852 lb.

Some measure of the craft's potency may be gained from its armament—four 37-mm. cannon and four .50-cal. machine guns. Furthermore, bomb capacity is 6,400 lb., affording alternate accommodation for a torpedo.

Designed and built by Convair's Vultee Field Div., the XA-41 made its first flight on Feb. 11, 1944, at Lomita, Cal. The plane was subsequently tested by the AAF at Eglin Field, Fla., and by the Navy at Patuxant, Md.

At present owned by the AAF, the craft has been assigned to the Pratt & Whitney Aircraft Corp., Hartford, Conn., where it is currently being utilized to flight test new engines.

TWA
TRANS WORLD AIRLINE

Uses

VICKERS

Hydraulic Equipment

On its LOCKHEED CONSTELLATIONS

Illustrated below are various types of Vickers hydraulic units used on Lockheed Constellations now being flown by TWA.

Vickers Variable Volume Piston Type Pump automatically delivers volume of fluid required by main hydraulic system . . . never is an excess of fluid pumped. An integral pressure control automatically and continuously maintains the desired pressure independent of varying volume demand and of engine speed. Volumetric efficiency and overall efficiency are very high.

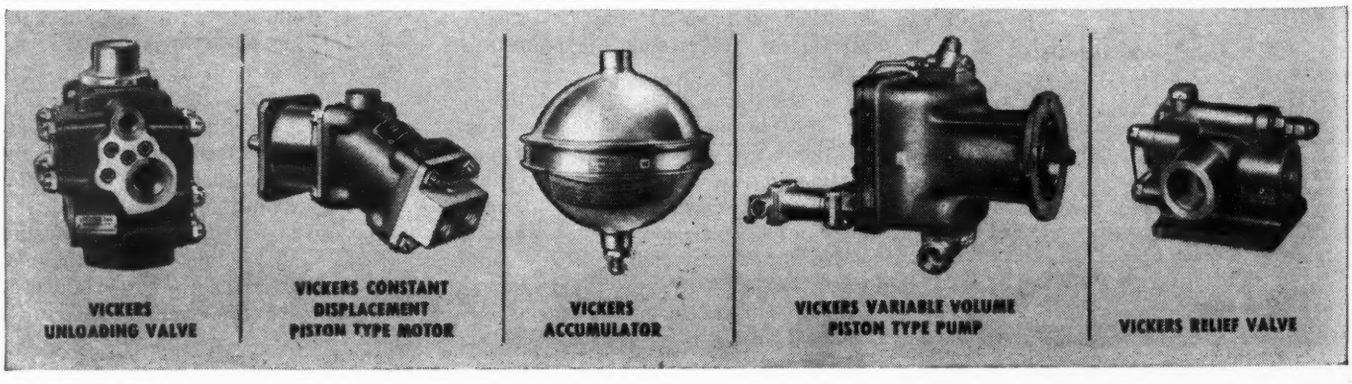
Vickers Hydraulic Motors are used for wing flap operation because of their high starting and running torque. They can be stopped accurately to position . . . no clutches or brakes are needed. The very low inertia of their moving parts permits instantaneous starting and stopping. They have exceptionally high horsepower/weight ratio.

Vickers Relief Valve, Unloading Valve, and Accumulator are used in the auxiliary flight control booster system. Relief Valve has a pilot operated piston resulting in smoother operation and greater accuracy. Accumulator has a very high volume/weight ratio. Write for Bulletin 45-41 for additional information.

VICKERS Incorporated • 1462 OAKMAN BLVD. • DETROIT 32, MICHIGAN

Engineers and Builders of Oil Hydraulic Equipment Since 1921

1918



VICKERS UNLOADING VALVE

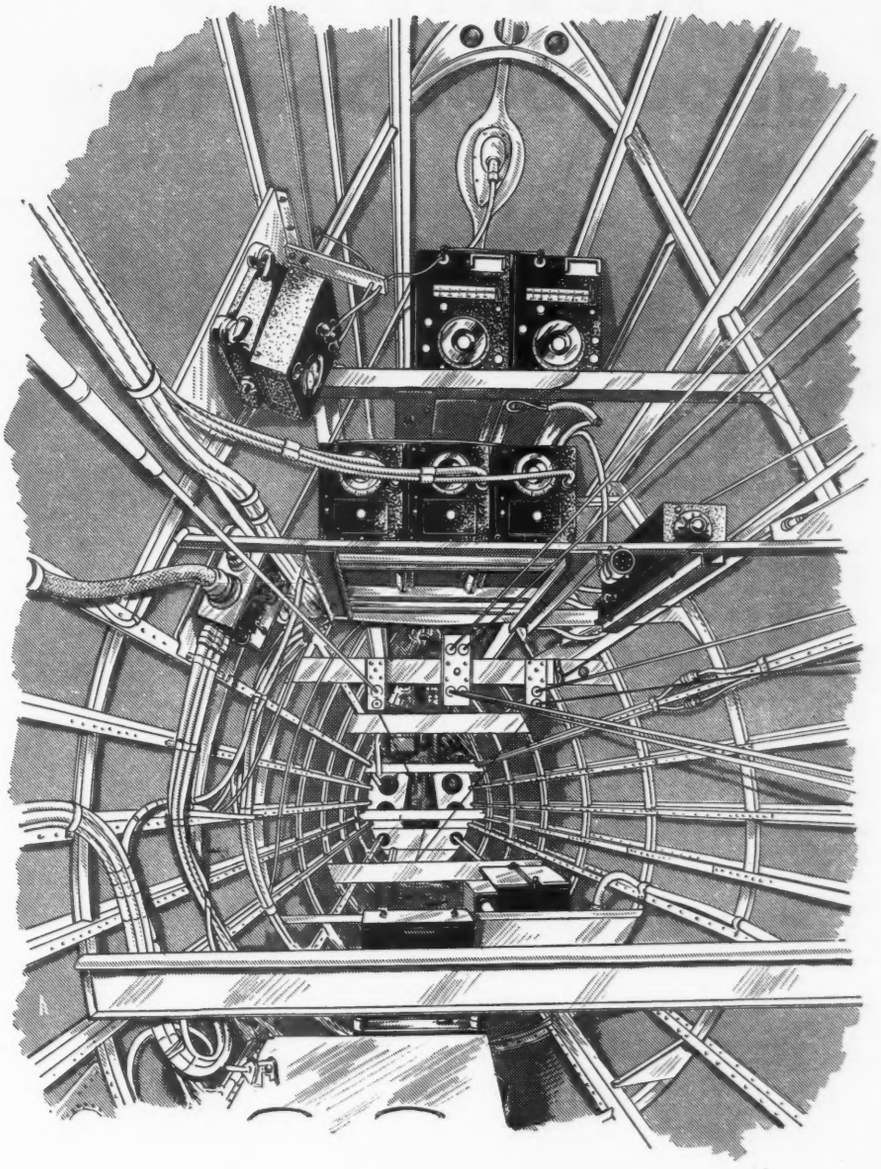
VICKERS CONSTANT DISPLACEMENT PISTON TYPE MOTOR

VICKERS ACCUMULATOR

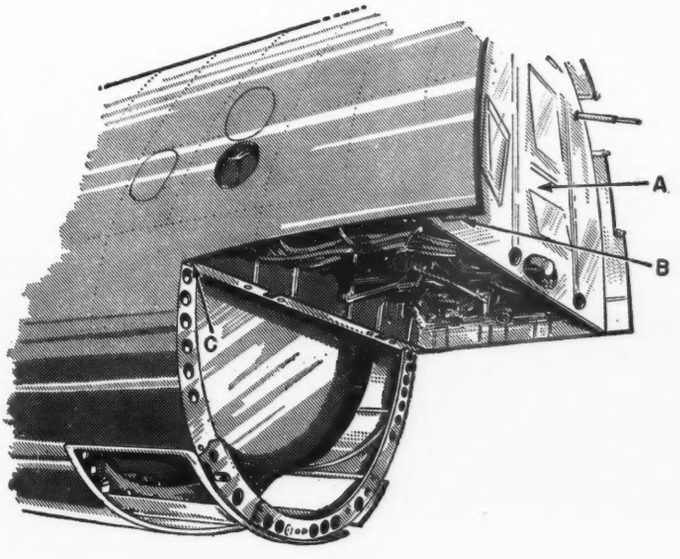
VICKERS VARIABLE VOLUME PISTON TYPE PUMP

VICKERS RELIEF VALVE

AVIATION'S SKETCHBOOK OF DESIGN DETAIL



Interior view of Grumman F6F Hellcat fuselage looking aft, showing elevator and rudder control cables and horizontal structural members for support of radio and other equipment.



Wing of F6F attaches to fuselage at cutout below firewall (A), with front spar being bolted to fittings, as at (B), and rear spar to fittings located inside fuselage at points (C).

The bare facts about ball bearings

Rugged New Departure Ball Bearings lick friction with free-rolling, tough, forged steel balls.

They welcome today's more exacting requirements of higher speeds, heavier loads and *continued* precise positioning of moving parts.

And . . . most important of all, New Departure, world's greatest ball bearing maker, meets your particular problems with a vast fund of experience and *original thinking.* 3412

Cut-away view of New Departure Ball Bearing

UNITED SERVICE MOTORS

Sign of prompt bearing service by authorized distributors

nothing rolls like a ball

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • Division of General Motors • BRISTOL, CONN. • Branches in DETROIT • CHICAGO • and Other Principal Cities

1

Nothing Rolls Like A Ball. It is nature's favorite, strongest form. Having no ends, it rolls freely in any direction.

2

Under heavy compression it deforms slightly and then resumes its original form. Made of the toughest, most resilient steel known to man, the New Departure steel ball is of uniform structure throughout.

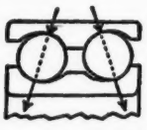
3

Its inherent resistance to load is greatly increased by curved raceways which, under load, are nearly filled by an arc of the ball. "Point contact" talk is the bunk. Actually, its contact is an ellipse, like this: ⬬

4

This is how a ball resists thrust (axial loads) as well as radial loads — like a bicycle on a banked track.

5



Put two rows of balls together, and you can support thrust and radial loads from any direction. They may be in one single bearing or in two separate bearings.

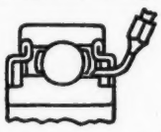
6

Unlike other types of rolling elements, the ball need not be forced to travel in the proper direction. Function of separator is merely to keep balls spaced. Contact is at poles (point of slowest rotation—least friction.)

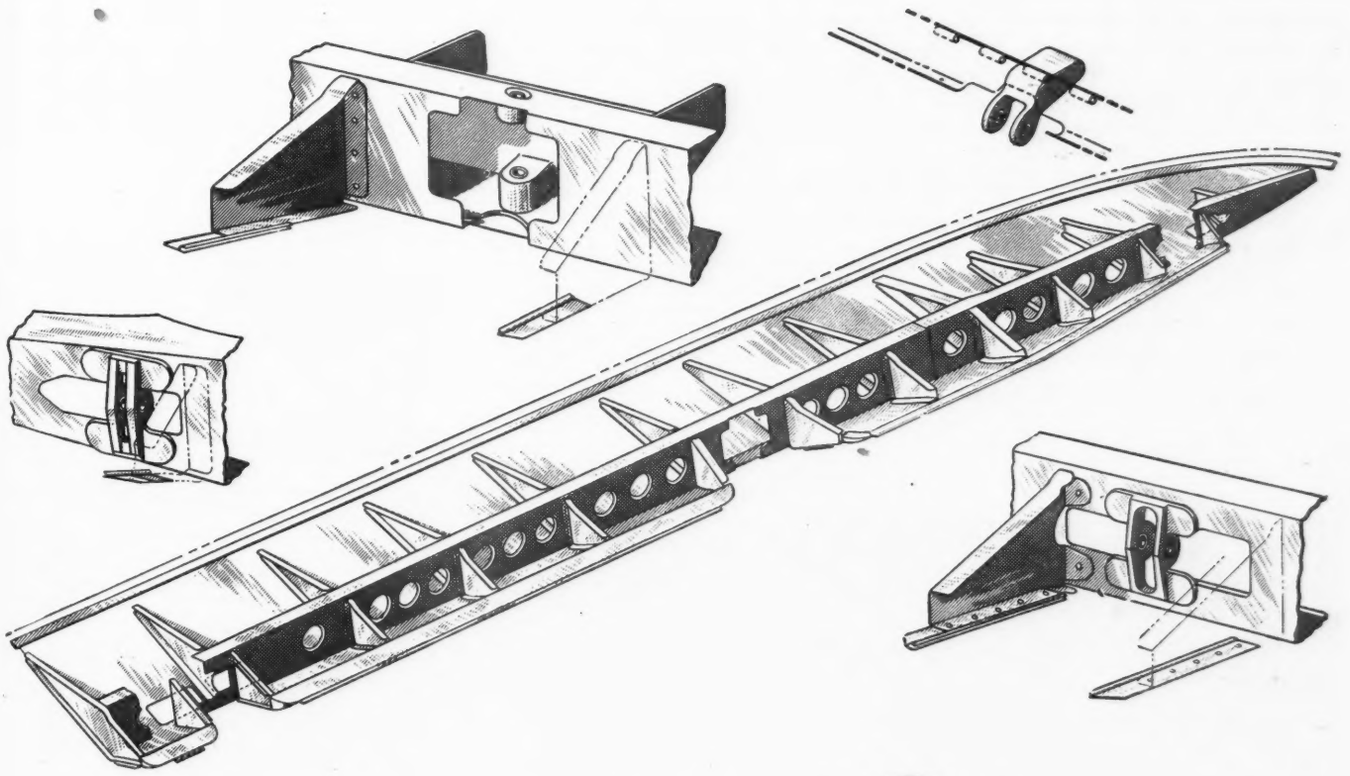
7

Only ball bearings may be self-sealed with integral closures of felt and metal. In average conditions New Departures are lubricated for life. Other type bearings cannot maintain precise "inter-fitment" needed to maintain efficient sealing.

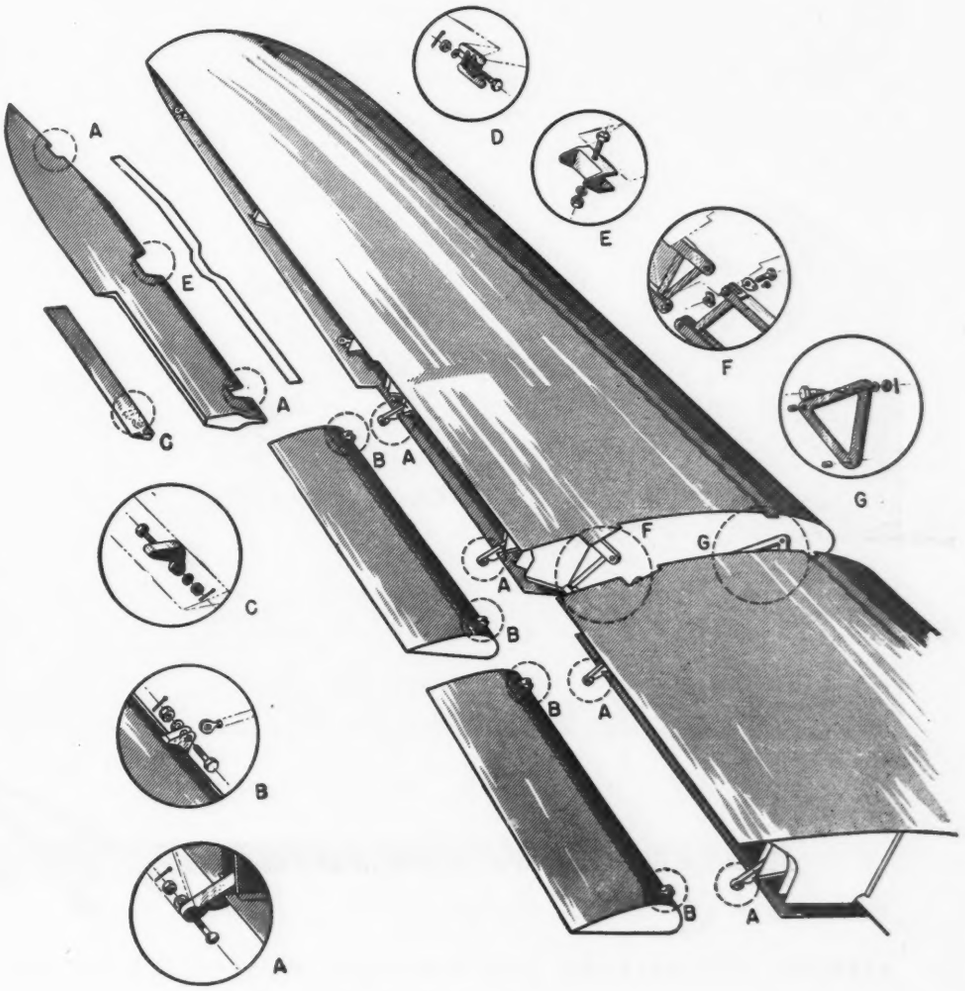
8



Newest new departure *by* New Departure: Lubrication in new sealed bearings may be revitalized by injecting with hollow needle on pressure oiler—without removal of seals or need for nipples, grease passages, plugs.



Above: Ryan FR-1 Fireball aileron comprises main spar, false spar, extruded aluminum alloy spacers, stamped ribs, and flush-riveted metal skin. Spars are formed of C-sections. Ailerons are hinged at three points; trim tab by continuous hinge.



Right: Exploded view showing major components of FR-1 Fireball wing, a shell type structure in which all bending stresses are taken by its single spar, and torsion by the skin, with ribs serving only to support skin contour to prevent buckling.

The Condor meets his match...

In South America the Andes tower into the sky along nearly 5,000 miles of unbroken mountain chain. Nestled among its peaks, like the lofty homes of soaring condors, are the havens of man-made birds—the highest commercial airports on the globe.

Most of these fields lie at altitudes averaging 8,000 to 10,000 feet. One airport is 13,300 feet above sea level. At altitudes such as these, the weight factor at take-off is a critical one. Thus, these Andean fields furnish a number of interesting examples of how jet assisted take-off can solve completely the problem of payload limitation at higher altitude airports.

The following comparison, made for a field which might be at an 8,000 feet elevation, shows conclusively how Aerojet Assistance not only increases the payload, but also provides a generous margin of safety:

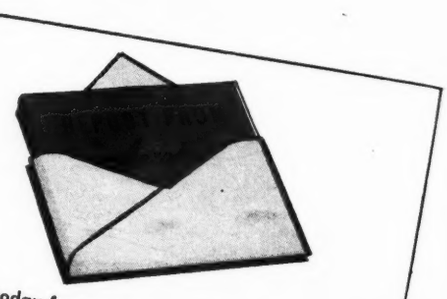
8,000 Feet—DC-3 Take-Off Flight Path Comparison

1. Distance required *without jet assistance* to reach a height of 50 feet, assuming one engine fails at take-off speed:

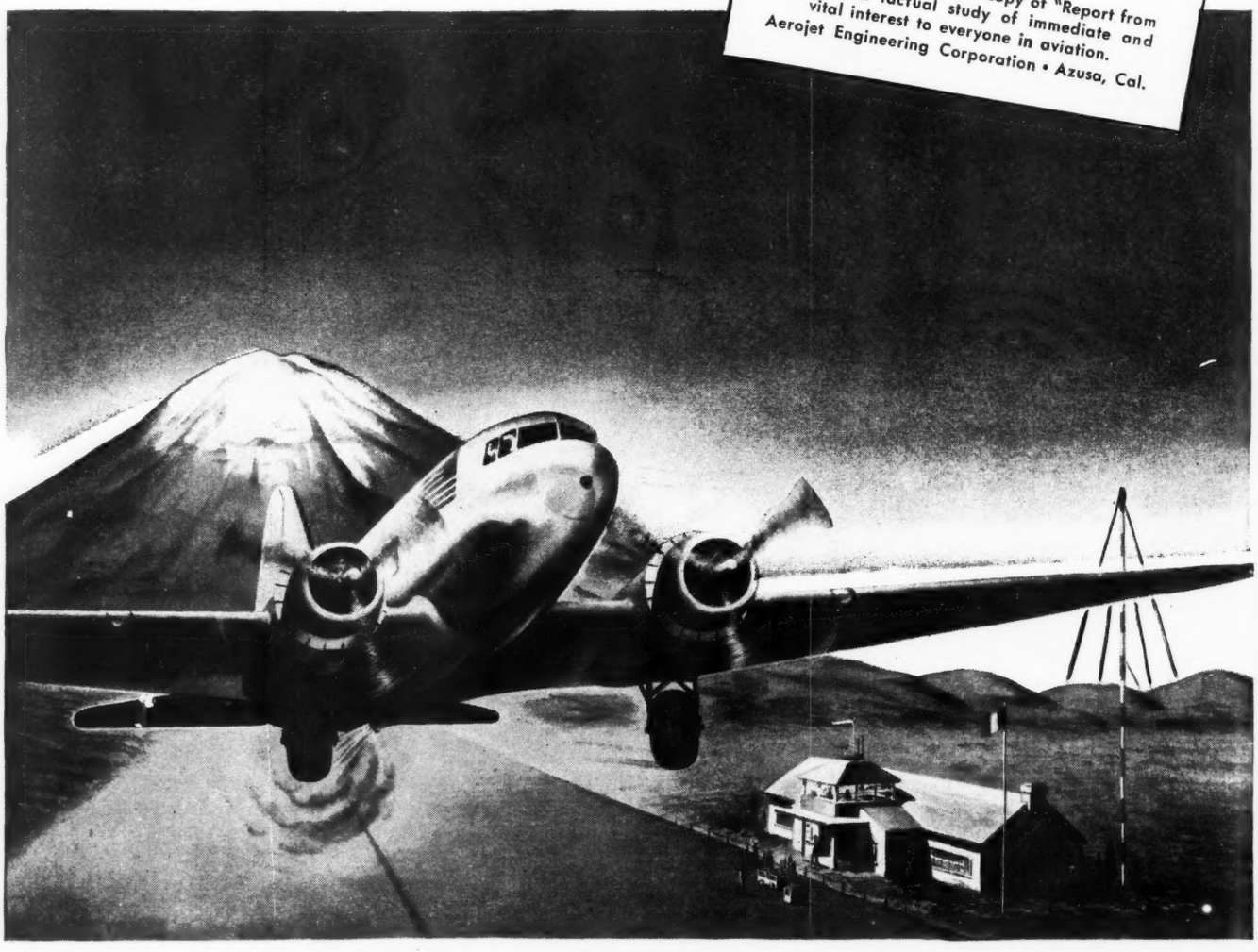
Weight	*Distance*
22,000 lbs.	5630 ft.
23,000 lbs.	6780 ft.
24,000 lbs.	(Will not leave ground)

2. Distance required, *with 1000 lbs. of jet motor thrust for 14 seconds* to reach a height of 50 feet, assuming one engine fails at take-off speed:

Weight	*Distance*
22,000 lbs.	3185 ft.
23,000 lbs.	3500 ft.
24,000 lbs.	3790 ft.
25,200 lbs.	4260 ft.

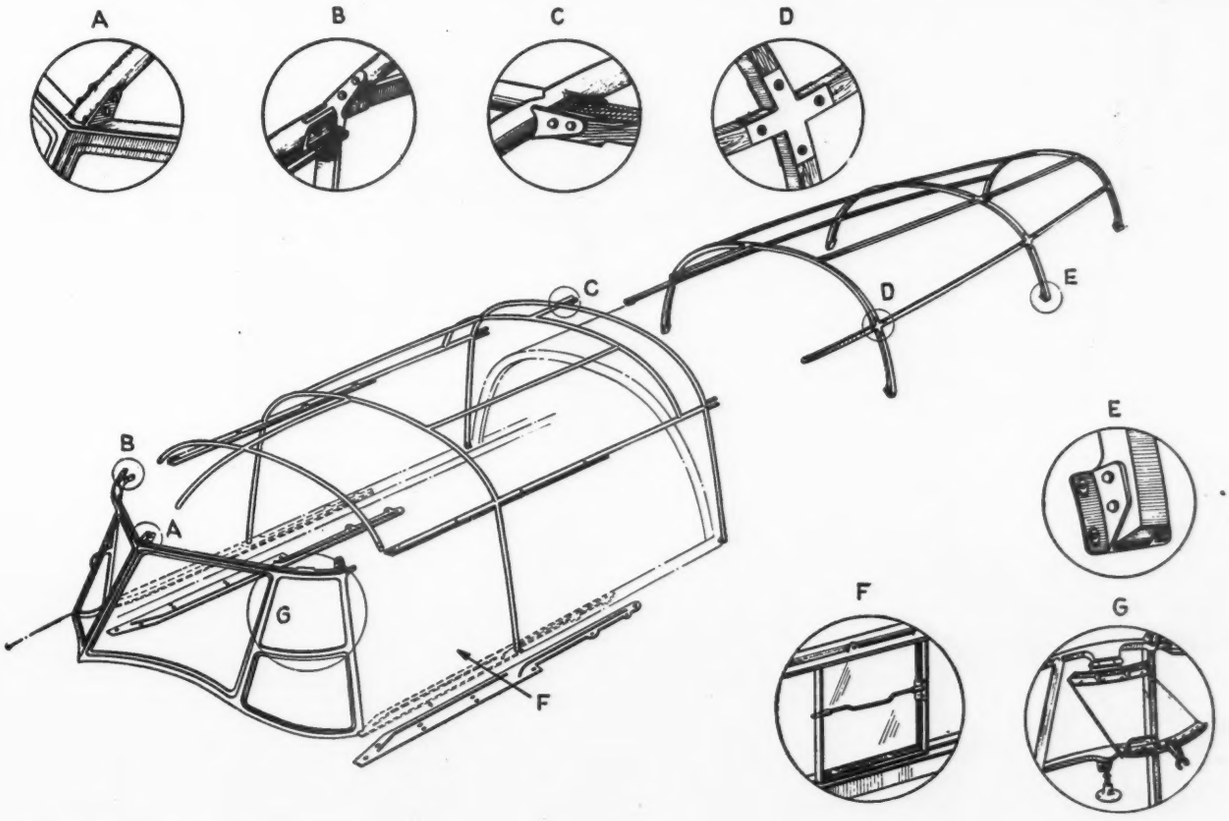


Send today for your FREE copy of "Report from Aerojet"—a factual study of immediate and vital interest to everyone in aviation.
Aerojet Engineering Corporation • Azusa, Cal.

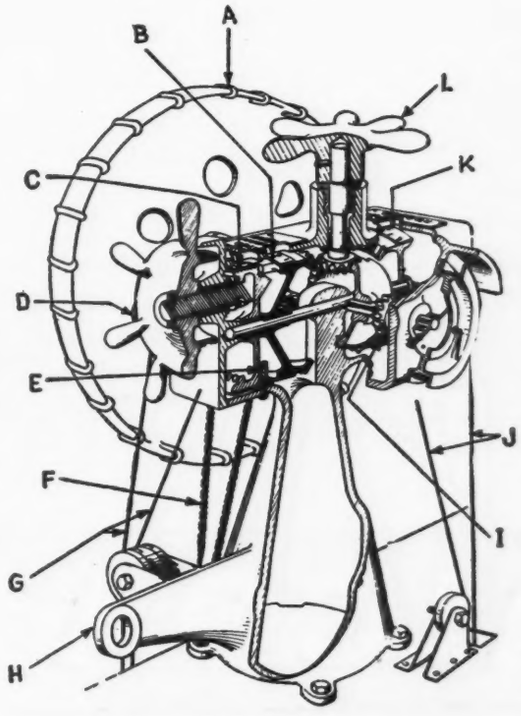


THE POWER OF ... Aerojet

AEROJET ENGINEERING CORPORATION • AFFILIATE OF THE GENERAL TIRE & RUBBER CO.

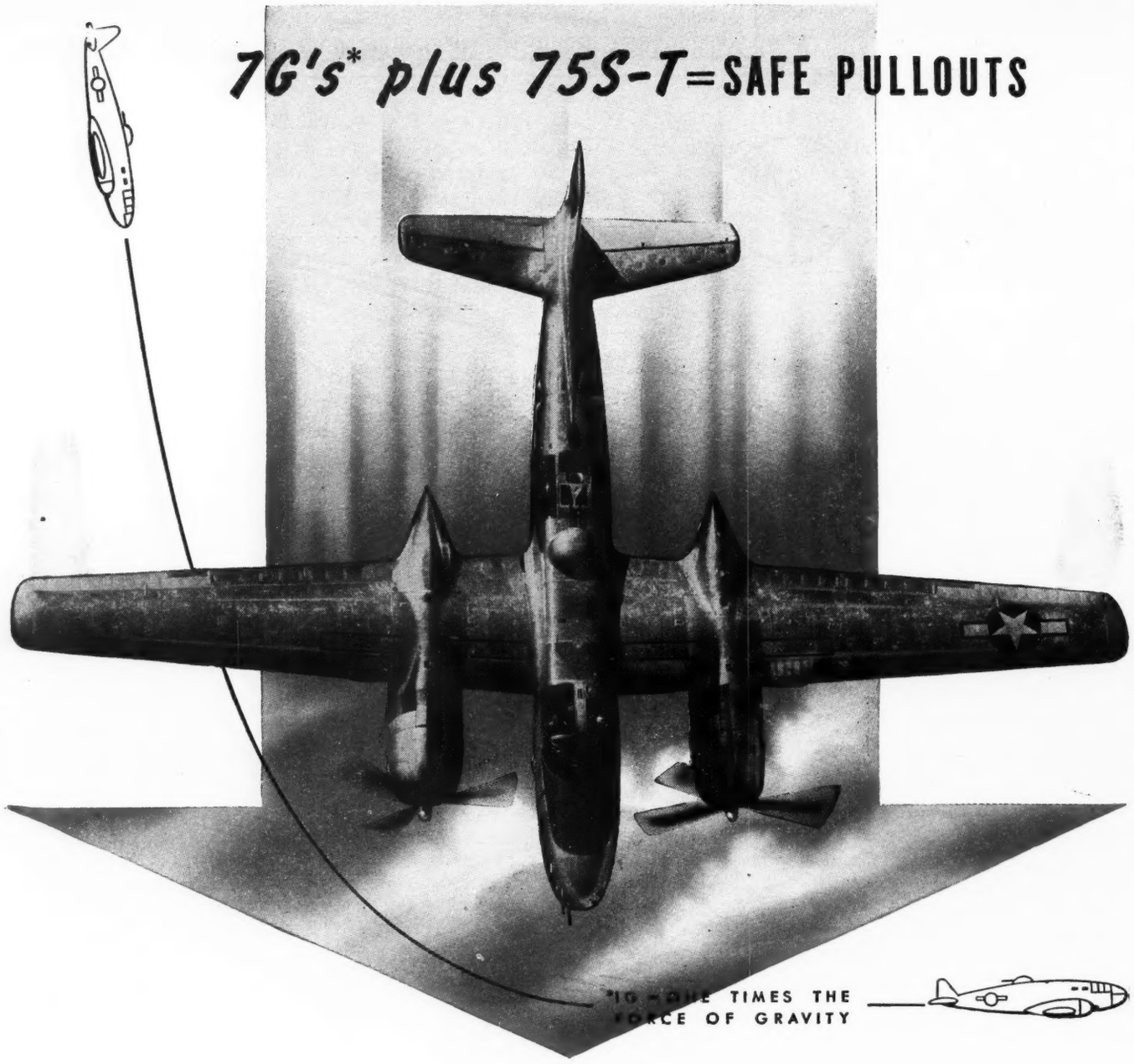


Cockpit canopy construction of Avro Lancaster. Illustrated at (A) is center joint of windshield frame to steel tubes forming top of structure, (B) side joint of windshield frame to steel tube, (C) joint of spruce contour frames to steel tubular structure, (D) joints in spruce frames themselves, (E) joint of spruce frame to fuselage top, (F) sliding window, and (G) small direct-vision window set in top forward part of windshield.



Cutaway view of Lancaster trim tab control box. Depicted are elevator trim tab handwheel (A), elevator trim indicator (B), aileron trim indicator (C), aileron cable handwheel and drum (D), elevator and aileron indicator stop (E), chain section of elevator cables driven by sprocket on handwheel (F), aileron tab cables (G), fulcrum for flap control lever (H), bevel gear to operate rudder trim indicator (I), rudder trim tab cables (J), rudder trim indicator (K), and rudder trim handwheel (L).

7G's* plus 75S-T=SAFE PULLOUTS



Pull-outs of 7G's impose terrific strains on wings.

In Douglas A26 Invaders, with wing spar caps of Alcoa 75S-T stepped extrusions, the safety factor was well in hand. This amazingly high-strength aluminum alloy, increased static test results to 115% of rated load . . . without a weight penalty.

This is just one of the many airplane applications for Alcoa Alloy 75S-T, where highest strength with accompanying light weight are major design factors. For information on the amazing characteristics of this alloy and where it can be effectively employed in your airplane, write ALUMINUM COMPANY OF AMERICA, 2182 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

INTEGRAL SEALING RING FEATURED IN NEW RIVET

SEEN AS A STRUCTURAL CONTRIBUTION in the trend toward commercial pressurized-cabin flight is a self-sealing rivet (Figs. 1 and 2) featuring a concentric hump on the underside of the head, to compensate for various factors responsible for leaky installations.

Designated by the maker, Cherry Rivet Co., as the "Keg" (from the initials of its designers—Boeing engineering process unit chief, C. P. Keeble; manufacturing coordinator, G. Eckberg; and rivet supervisor, L. Goldman) the new fastening unit effects an airtight joint by deforming the seal ring (hump) to provide sufficient surplus material to fill irregularities in the surface under the rivet head.

Originally devised for installation in the B-29 Superfortress, utilization of the Keg rivet will eliminate 1,581 ft. of sealing tape weighing over 11 lb. and permit attendant savings of many production man-hours. Whereas tape or compound successfully seals the B-29 fuselage, its application is troublesome and messy. Involved is surface cleaning before sealant is applied, punching or reaming of rivet holes through the tape, and cleaning up after riveting. And it's also likely that tools and hands will pick up a greasy coating.

For comparison of pressure-sealing characteristics of countersunk seal ring rivets and standard countersunk rivets assembled with and without pressure sealing tape, production and laboratory tests were conducted. Substantiating evidence resulted to prove that the seal ring rivet effects a seal comparable to that achieved with a standard unit assembled with sealing tape and provides a far better seal than afforded by standard units employed without sealing aid.

In the laboratory test, three panels were compared, each having 50 hand-driven 78-deg. countersunk rivets. First panel was prepared with seal ring rivets assembled without utilizing any sealing aid; second panel was made up of standard rivets with pressure-sealing tape; and third panel also consisted of standard units, but without any sealing aid.

Panels were tank-tested at room temperature at various pressure-time values. Seal ring rivet panels and standard

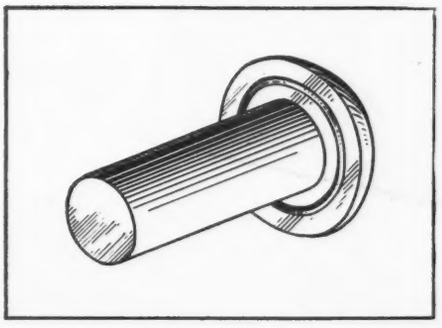


Fig. 1. Underhead view of Keg rivet. The self-sealing feature is concentric ring of metal, deformed with driving to provide sufficient surplus material for tight contact.

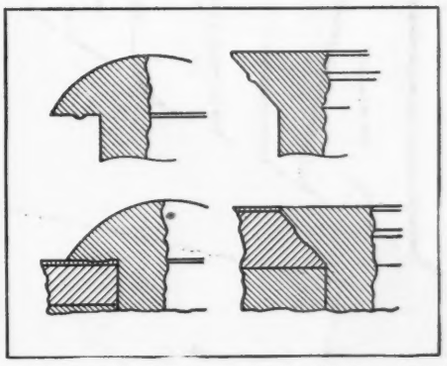


Fig. 2. Top: Sectional close-ups of modified brazier and countersunk seal ring rivet heads. Above: Close-ups showing deformation of ring.

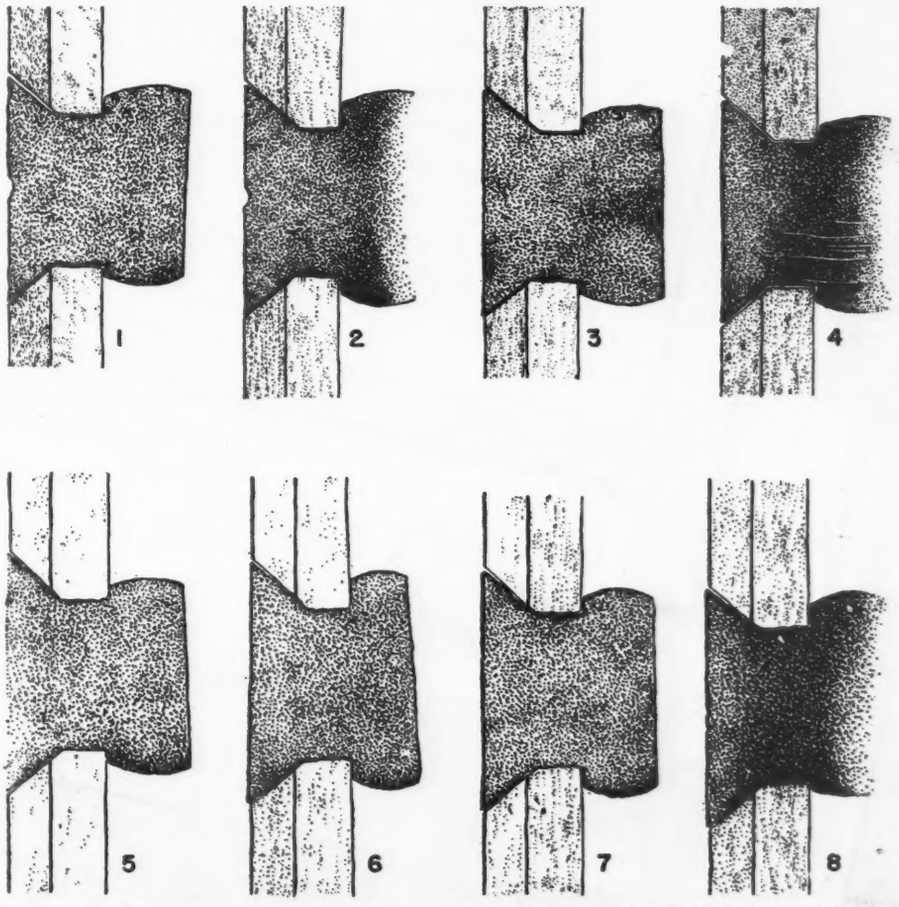


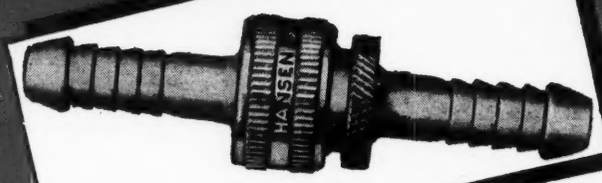
Fig. 3. Top: Photomicrographic aspects of standard rivets assembled without sealing aid. Various numbered installations seen gave these leakage conditions: (1) Excessive, (2) none, (3) negligible, and (4) excessive. Above: Similar aspects of seal ring rivets; (5) No leak; and (6), (7), and (8), negligible.

HANSEN

Industrial AIRLINE EQUIPMENT

For over a quarter of a century Hansen airline equipment has not only pioneered and paced the field but has acquired an international reputation as the finest "precision made" equipment of its kind.

Our engineers, highly specialized, have had years of experience in creating, designing and introducing to industry new and improved equipment which has met with tremendous success, as is evidenced by the users of Hansen equipment. From the largest industrial plants in the world down to the small ones, you will find Hansen equipment widely used. Hansen equipment has proven its worth, particularly in plants where peak production, economy, time and labor savings are essential.



UNION STEMS

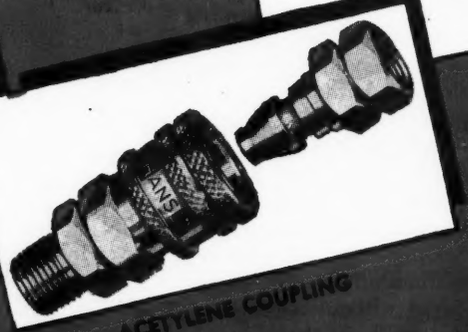
HOSE CLAMP

OXYGEN COUPLIN

HOSE STE

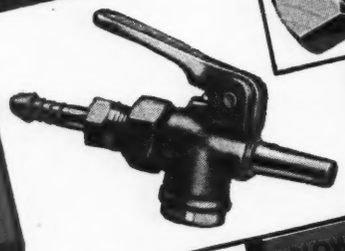
GASOLINE COUP

PUSH-TITE COUPLING

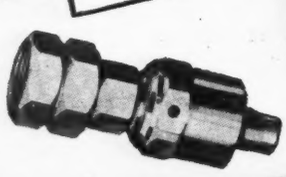


ACETYLENE COUPLING

PE & HOSE UNION



BLOW GUN



HANSEN MFG. CO.

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unit panels using sealing tape showed negligible leakage (less than 1 cfm.). Panels having standard units without sealing aid showed leakages of 6 cfm. at pressure-time of 6.5 psi. for 15 min., 32 cfm. at 10 psi. for 30 min., 48 cfm. at 16 psi. for 30 min., 86 cfm. at 20 psi. for 60 min., 80 cfm. at 0-20 psi. (pulsating 10 cycles per min.) for 60 min., and 82 cfm. at 20 psi for 30 min.

Fig. 3 shows photomicrographic appearance of typical leaking and non-leaking rivets from panel equipped with standard units (rivets 1 to 4, incl.) using no sealing aid, and also from seal ring panel (rivets 5 to 8, incl.).

Of the former panel, cross-section of rivet (1) shows a poorly filled hole and a gap under the flush head—typical of excessively leaking rivets. Cross-section of rivet (2) shows a better filled hole and countersink—typical of non-leaking rivets, giving evidence of better driving and correct hole size and countersink. Rivets (3) and (4), respectively, show negligible and excessive leaking conditions.

If control of all factors responsible for leaking rivets were possible, no sealing aid would be required to seal countersunk rivets—substantiated by the result that 26 of the 50 standard units, tested in the panel without sealing aid, did not leak.

Compensating for these factors, the ring on the self-sealing rivet is deformed with driving and fills the gap under the head to provide tight metal-to-metal contact. In the seal ring panel, cross-section of rivet (5) reveals the gap completely sealed off by the deformed ring. Sections of rivets (6), (7), and (8), which showed only very light leakage, also indicate ring-sealing characteristics.

In a B-29 production structure test, with 3,500 self-sealing rivets under 6.5 psi. at 67 deg. F., only 12 rivets developed leakage—determined by brushing on a water-soap solution. Amount of leakage was negligible and difficult to determine.

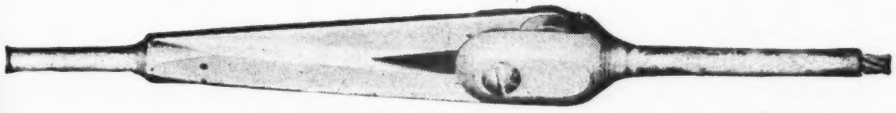
CONTROL CABLE QUICK-DISCONNECT EXPEDITES MAINTENANCE ACCESS

A UNIQUE CABLE FITTING—intended for use with control cable which requires "breaking" to permit access to fuel cells, piping, or accessories—features quick-disconnection to afford cable separation at access area, and also eliminates necessity of retensioning cable upon reconnection.

Designed by M. A. Cawl, Fairchild Aircraft Div. controls engineer, the unit consists of two opposed, connected cable terminals—one being a clevis with a "knife" leg hinged at the connection end, the other comprising a fork carrying a bushed bolt.

With the terminals interconnected to transmit pull, the clevis surrounds the fork bolt bushing, the knife leg of the clevis being secured by a cotter pin to the other clevis leg at the cable end. To break the terminal connection, the cotter pin is removed and the knife leg is swung to clear the bushing and then drawn out past the bushing for complete separation from the fork.

Reconnection is simply accomplished in the reverse order, without adjustment—insertion of knife leg, swinging it down into contact with other clevis leg, and securing with cotter pin. Since the relative position of the terminals have not been altered, there is no change in cable length or tension.



Two terminals—fork (right) and clevis (left)—comprise quick-disconnect for separating cable run to afford clear access to units behind cable in craft interior. Connected to fork by bolt, clevis consists of hinged upper leg and fixed lower leg secured by cotter pin through hole visible at cable end.

Shown here, hinged clevis leg is slightly separated from counterpart, with cotter pin holes visible in each. For separation from fork, hinged leg is swung up and down past connecting bolt in fork.

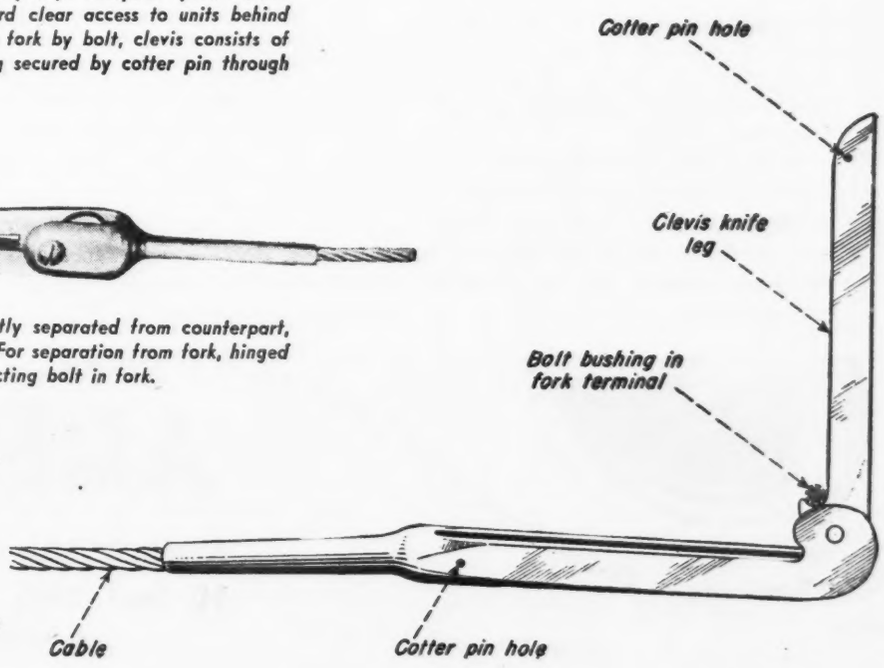
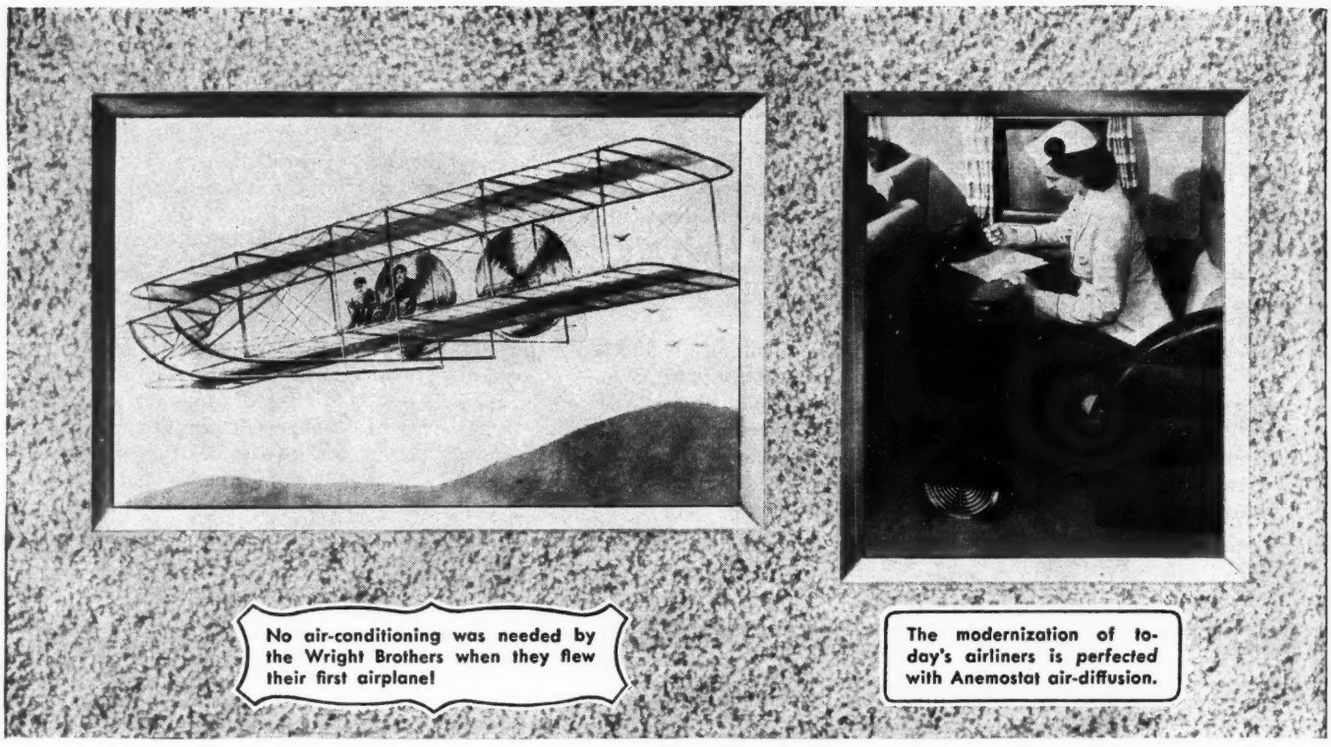


Diagram of clevis terminal in open position for separation from fork bolt.


No air-conditioning was needed by the Wright Brothers when they flew their first airplane!
The modernization of today's airliners is perfected with Anemostat air-diffusion.

GO ALL THE WAY! add ANEMOSTAT DRAFTLESS AIR-DIFFUSION

Only perfected modernization will meet tomorrow's competition

The difference between near-perfect comfort and true comfort is Anemostat draftless air-diffusion. For no air-conditioning system can provide real air-comfort unless the conditioned air is properly diffused.

When conditioned air is blown through out-moded grilles, registers, or ceiling plaques, drafts occur, while stale air-pockets with unequalized temperature and humidity persist.

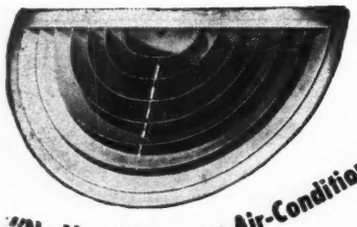
Rid passengers of these discomforts with Anemostat air-diffusers and you achieve perfected modernization—you "go *all* the way" to keep ahead of tomorrow's competition!

Anemostat air-diffusers are scientifically engineered to distribute just the correct proportions of conditioned air in pre-determined patterns. Drafts and stale air-pockets are eliminated. Temperature and humidity equalization is constantly maintained.

This is how: Cabin air, equal to about 35% of the supply air, is siphoned into the cones of the Anemostat. This cabin air is mixed with the incoming conditioned air within the unit—*and re-vitalized* — before it is re-circulated. Heated or cooled air, therefore, flows evenly from the Anemostat — spreading true air-comfort throughout the plane.

Furthermore, Anemostats simplify air-duct maintenance. The one-piece detachable inner assembly of the new Type "W" can be removed by a turn of a thumb-screw. Other types are hinge-mounted for full and easy access to the ducts. And, Anemostats cannot wear out — they have no moving parts!

For full information about Anemostat draftless air-diffusion and how they can help you perfect plane modernization, *write for bulletin today*. Or, if you have an immediate air-diffusion or air-conditioning problem, an Anemostat engineer is ready to assist you.



"No Ventilating or Air-Conditioning System is Better than its Air-Distribution"

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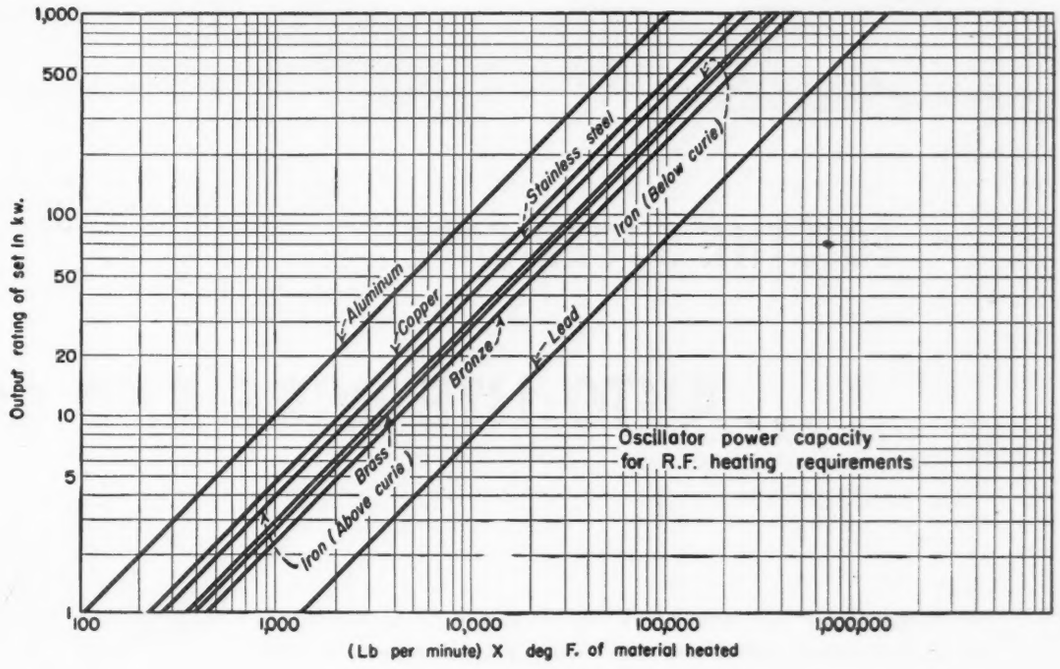
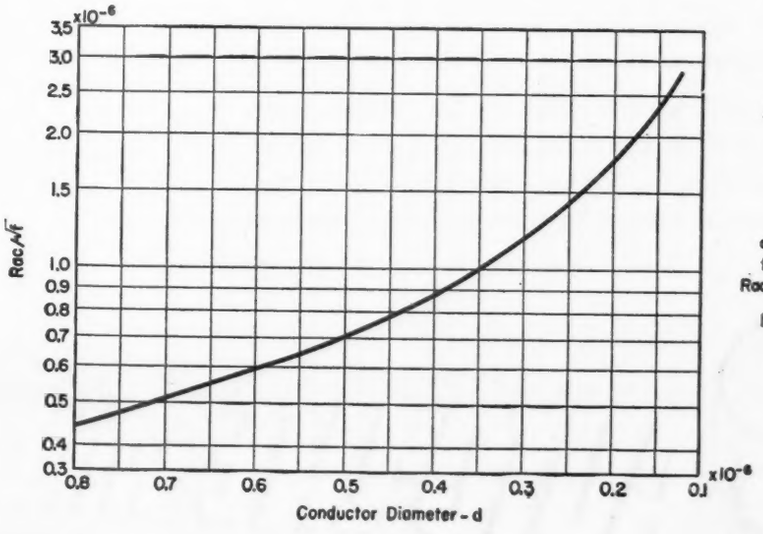
SHEET NUMBER ..... D-35 (cont'd)

CLASSIFICATION ..... Induction Heating

SUB CLASSIFICATION ..... Conductor Capacity

Induction Heating Data



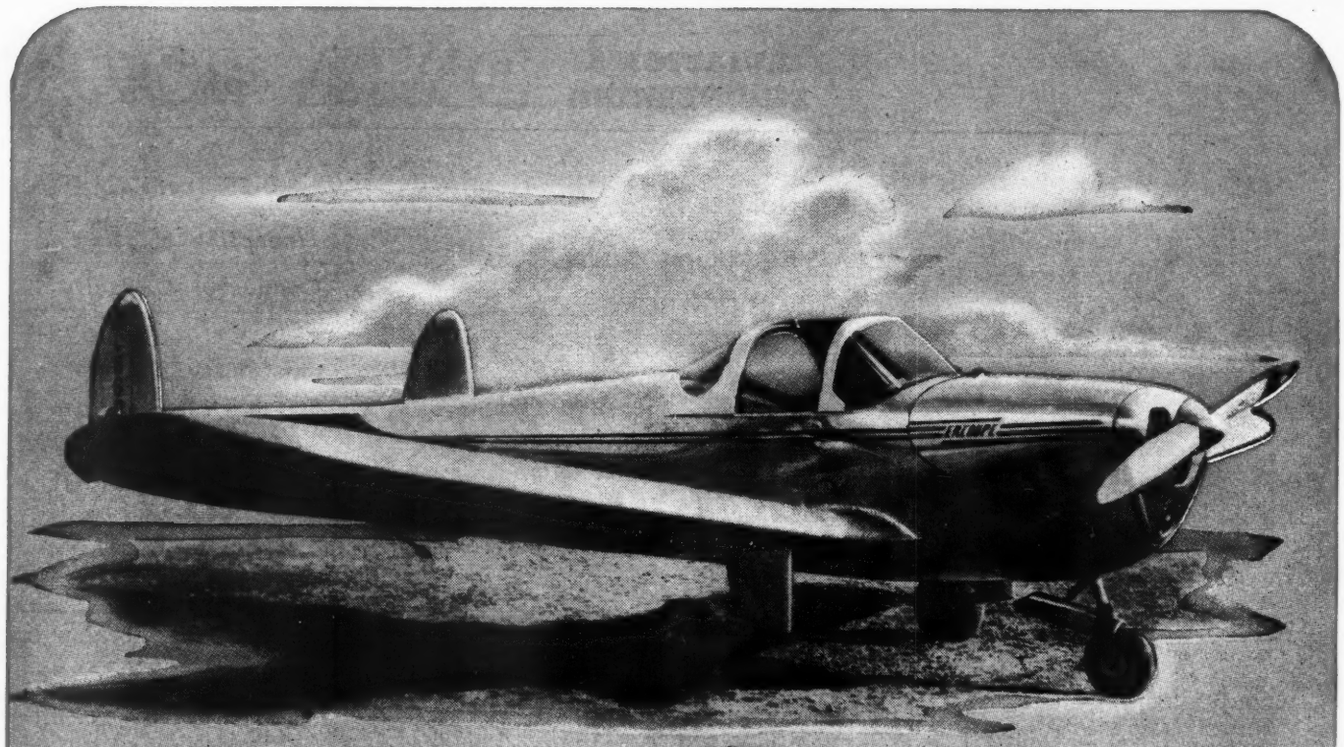


A.C. Resistance of Cylindrical Copper Conductor

$$\frac{Rac}{\sqrt{f}} = \frac{.35 \times 10^{-6}}{d}$$

d = Diameter of conductor (inches)
f = Frequency (cycles/sec.)
Rac = Ohms per inch of conductor

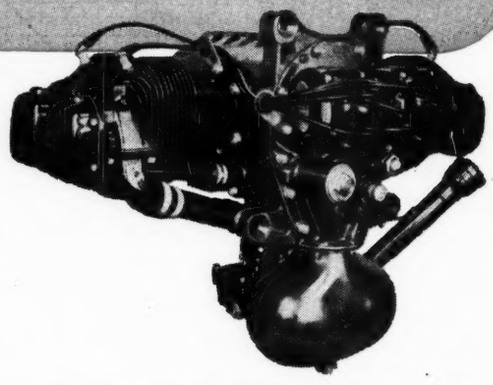
Note:
Resistivity of copper taken to be $\rho = 1.724 \times 10^{-6}$ Ohm-Cms



*Spin-proof Ercoupe, equipped with Auto-Lite low-tension wire, is certified "incapable of spinning" by the U. S. Civil Aeronautics Administration.

FOR THE SUPER-SAFE ERCOUPE

... AUTO-LITE WIRE AND CABLE



Continental 75 H.P. motor used to power Ercoupe, equipped with Auto-Lite Aircraft Spark Plugs and spark plug wire.

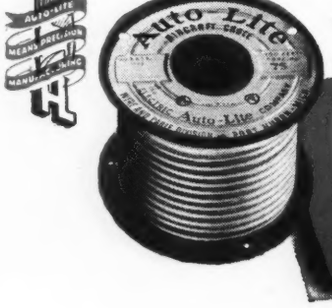
The safety of the new spin-proof *Ercoupe is matched by the dependability of the equipment used on this famous plane. It is significant that Erco engineers specify Auto-Lite aircraft wire for both the plane and the engine which powers it.

Auto-Lite wire and cable is available in a wide variety of sizes, shapes and insulations for both low-tension and high-tension systems. To get complete information on the many types of Auto-Lite wire and cable, write to

SARNIA, ONTARIO — **THE ELECTRIC AUTO-LITE COMPANY** — PORT HURON, MICH.

Wire and Cable Division

TUNE IN THE AUTO-LITE RADIO SHOW STARRING DICK HAYMES
EVERY SATURDAY NIGHT, 8:00 P.M.—E.T. ON CBS



AUTO-LITE *Aircraft* WIRE & CABLE

SIDE SLIPS

FOR A MINUTE, yesterday, we were practically out of the publishing business and into airport operation —and boy did we feel good for that minute. It happened this way: One of our associates came barging in with a catalog and said, "How'd you like to buy a surplus airport, but really cheap?" Grabbing said catalog, we dived to the page which the index listed for airports, and sure enough there it was— "Airports, new, good condition, $30 each; in lots of 20–50, $12 each." But then we read the description: "Brass, 15 in. dia., with 1-in. thick glass, deadlight, and 5/8-in. spigot."

Wish to goodness those sailors would learn to call a porthole a porthole.

• We just received a publicity handout reporting on a telegraphic "feud" between a couple of Chambers of Commerce, Junior style, as to where flying really was born in this country. The boys are, of course, trying to get their respective Chambers in the papers, but more obviously are being used to further the promotion of a forthcoming movie. Maybe we're getting old and stuffy, but we couldn't help thinking how much more useful both chambers would be if they spent the same time and effort on constructive programs to increase personal flying now—and tomorrow—in their communities. That's a job that needs some work; the movie'll make money with or without them.

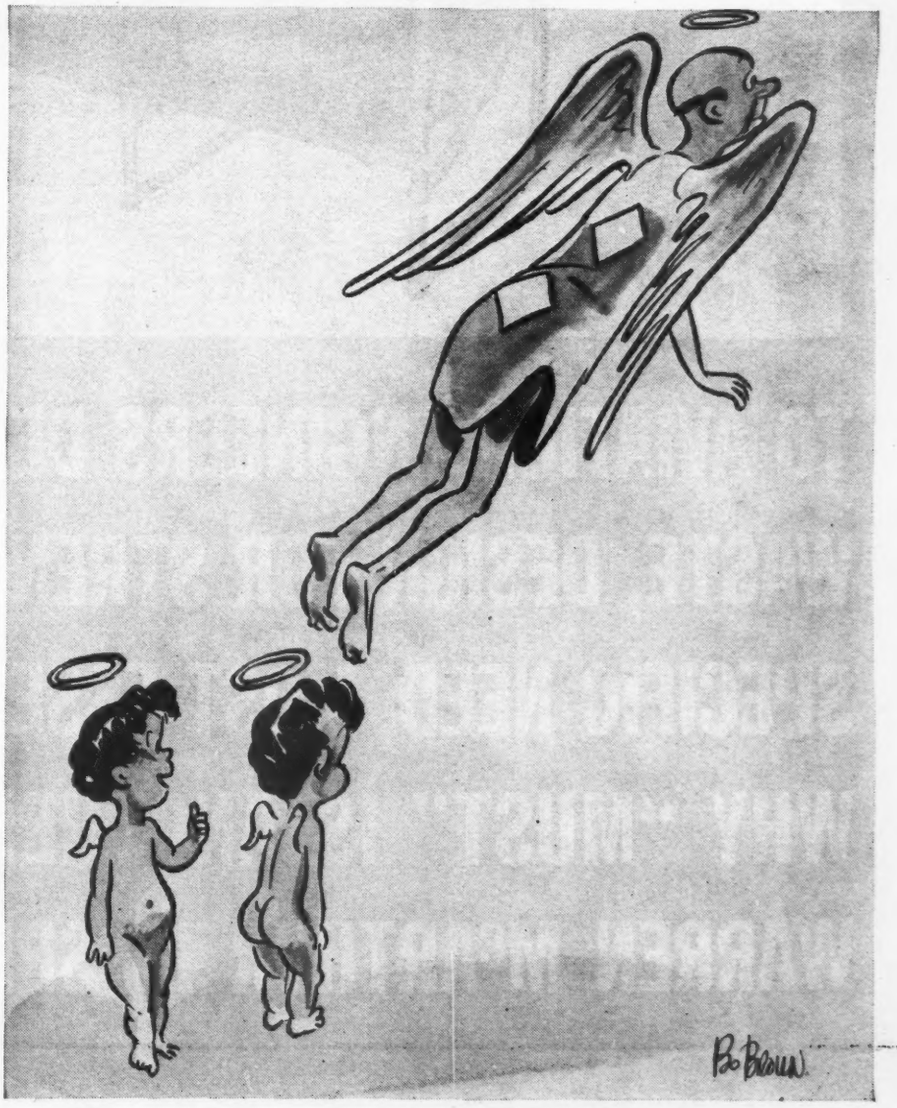
• The young lady had just successfully passed a check flight; her ticket was in good order. All of which made it easy to dally in the afternoon sunshine and postpone—just a few minutes longer—returning to the airport from which she had rented the plane. On the way back, as sometimes happens, she got herself completely lost and, as she later wrote in her report, "a dark cloud suddenly descended" upon her. Somehow she got the ship down in the only available open space—on a big lawn near what looked like the main building of quite an estate. Climbing out of the ship, she wandered through the first door and found herself in a cafeteria occupied only by a husky gent in the usual white coat. Approaching him she said, "Excuse me, I just had to land my plane on your lawn and I want to . . . ." Patting her paternally on the shoulder, he replied, "That's all right, little girl—you just sit down and have something to eat, and then I'm sure the doctor will take care of you." Yep, she had landed on the grounds of a private mental institution, and she says she *was* almost nuts before she got out.

• The Colonel blew his top when the Wac control tower operator reported for duty at his advanced fighter base. Wimmin, he figured, had no place being there; anyhow, he sure didn't want one messing things up from the tower. But, since orders were orders, he finally agreed to give her a chance, even though he was certain she couldn't handle the job.

Then, the first time the boys upstairs heard her voice, one of 'em immediately shot her a call, "Red bird tower, red bird tower, this is Buck Rogers at 50,000 ft., may I have landing instructions?"

Without batting an eye she cracked back, "Red bird tower to Buck Rogers, circle the earth twice—Flash Gordon just overshot the field."

• We've just read a four-and-a-half page—single spaced—"letter" from an airline press agent saying farewell to a plane on which his line made much of its reputation. The writing would have done credit to a Hollywood sob sister—almost. For in all the four and a half pages there is nothing but the line's own name for the ship—not one single mention of the type of plane it was; not one solitary mention that a manufacturing company had designed and built the ship. Can't you imagine how that generous soul's poor heart bled as he said farewell?



"No, those aren't inspection panels — Maguire's caught in the fabric shortage."

WARREN McARTHUR

SEATS FOR THE MIGHTY

WARREN McARTHUR MODEL 154-2J PASSENGER SEAT

TO AVIATION ENGINEERS DEAD WEIGHT IS WASTE, DESIGN FOR STRENGTH TO MEET SPECIFIC NEED, MOST ESSENTIAL. THAT'S WHY "MUST" IS ANOTHER WORD FOR WARREN McARTHUR IN SPECIFICATIONS.

WARREN McARTHUR CORPORATION

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THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULBAN, New York

Federal Airport Act Signed by President; N-S Safety is Promoted by CAR Part 42

. . . Pogue bid to PICAO . . . AAF engineering center gets a wary eye . . . Energy is Bikini prime point . . . Service merger still halted . . . Air policy bill hits hurdle . . . Most surplus craft sold.

Pres. Truman signed the Federal Airport Act, authorizing expenditure by the government of $500,000,000 for more than 3,000 new airports in the next 7 yr., with matching funds to be provided by local legislatures.

This will be the nation's first planned effort to provide for a civil airport system and to boost the general use of airplanes for personal travel. CAA will pass on applications for Federal funds, with local governments handling actual construction themselves, through contractors or otherwise. Some difficulty may be encountered because of Veterans' Housing Program Order No. 1, recently issued by the Civilian Production Administration.

Falling under the classification of roads, construction of runways, taxiways, and aprons are interpreted as being exempt from general building restrictions. But construction of buildings on airports is prohibited during the emergency housing period.

N-S Safety is Promoted By New CAR Part 42

CAB's new Part 42 of the CAR, which goes into effect Aug. 1, indicates the increasing attention the government is giving to safety in non-scheduled operations. Meantime, officials state that the new technical requirements represent but a modest beginning, and they don't believe any operator will be put out of business. However, an economic policy is in the making, with CAB considering submission of regular written reports to form a basis for overall changes in regulations.

Earlier, about 100 new nonscheduled airline operators met in N. Y. C. and demanded regulation by CAA and CAB. Prewar N-S operators, then mostly of the 1920s' generation, had previously opposed regulation of any kind.

N-S safety is promoted by new Part 42 requirements for: An Air Carrier Operating Certificate; definite minimum of instruments and equipment; higher pilot qualifications and higher weather minimums; pilot flight time limitations; minimum fuel requirements; flight record filing; and keeping a check-off list in the cockpit describing takeoff procedure.

Pogue Bid to PICAO

Word came that the resignation of L. Welch Pogue as CAB chairman had been officially accepted by Pres. Truman, who then requested that he serve as delegate to PICAO's first annual assembly at Montreal, running from May into June. Previously, Mr. Pogue had agreed to continue as CAB head until this month, when new chairman was to take over.

Succeeding to the post is James M. Landis, who has been associated with Harvard U. as dean of Law School.

AAF Engineering Center Gets a Wary Eye

AAF proposal to set up a huge air engineering development center at an initial cost of $300,000,000 is being viewed cautiously by the industry.

Maj. Gen. Curtis E. LeMay, deputy chief of staff for research and development, stated that the AAF could no longer depend upon small contracts to companies for development of air weapons, and he proposed that the government furnish facilities to do the work.

The AAF's program would encompass even such advanced projects as development of space vehicles, bases, and space survival equipment, utilization of nuclear energy for propulsion, harnessing of light rays for destructive purposes, etc.

The center would be available to all government and civilian agencies engaged in aircraft design and production. At this writing, NACA, whose field is basic research and not application, had not yet commented on the proposal.

Energy is Bikini Prime Point

When the atomic bombs are unleashed at Bikini Atoll, main scientific interest will not be what the blasts do to the targets, but rather the efficiency with which the A-bomb charges are converted into energy. The tests have been widely confused as being designed primarily to find out the effects of the new weapon on navies. However, as we go to press, officials declare that the primary interest of the technical directors of the tests will be in the supersolar heat

(Turn to col. 1, page 112)

BELL'S NEW FIVE-PLACE 'COPTER

Company's latest design, now being tested at Buffalo, is Model 42 five-seater, stated to have a top speed of 125 mph. and cruising speed of about 100 mph. with a 450-hp. engine. Range is estimated at 300 mi. and endurance as 3 hr. Craft has a gross weight of 4,891 lb. and normal useful load of 1,445 lb. Two-blade rotor system is fitted with Bell's patented automatic gyro stabilizing bar.

★ COMING UP ★

June 12-15: International Air Show, DeHavilland Airport, Toronto (sponsored by National Aeronautical Association of Canada). NAAC Third National Air Conference will be held concurrently (June 14-15).

June 13-14: IAS Light Aircraft Meeting, Rackham Educational Memorial, Detroit.

June 13-15: First Postwar Annual New England Lightplane Tour, sponsored by New England Aviation Trades Assn., Metropolitan Airport, Norwood, Mass.

June 15-16: First Annual Southeastern Air Show & Exposition, Municipal Airport, Craig Field, Jacksonville, Fla.

June 24-28: American Institute of Electrical Engineers 1946 Summer Convention, Statler Hotel, Detroit.

June 25-26: ADMA officers, directors, and committee chairmen, open meeting, Hotel Traymore, Atlantic City, N. J.

July 17-19: NAA national convention, Omaha.

July 18-19: IAS national annual summer meeting, Hotel Hollywood-Roosevelt, Los Angeles.

July 18-21: World's Fair of Aviation, Omaha.

July 26-27: NAA Joint Private Flying Conference, Milwaukee.

July 29-30: NAA Joint Air Youth Training Conference, Milwaukee.

Aug. 1-2: The National Flying Farmers Assn. First Annual convention & Oklahoma Flying Farmers Conference, Oklahoma A & M College, Stillwater, Okla.

Aug. 15-16: IAS Annual Summer Meeting, Los Angeles.

Aug. 21-28: First World Congress on Air Age Education, International House, New York City.

Aug. 22-24: SAE National West Coast Transportation & Maintenance Meeting, New Washington Hotel, Seattle.

Aug. 30-Sept. 7: First postwar Canadian air show, sponsored by NAA of Canada, DeHavilland Airport, Toronto.

Aug. 31-Sept. 2: National Air Races, Cleveland

Sept. 4-12: Air Fair, sponsored by Aviation Council of Metropolitan St. Louis, Inc.

Oct. 3-5: SAE National Aeronautic Meeting & Aircraft Engineering Display, Biltmore Hotel, Los Angeles.

Oct. 14-17: National Aviation Clinic, Oklahoma City.

Oct. 16-17: SAE National Transportation & Maintenance Meeting, Hotel Knickerbocker, Chicago.

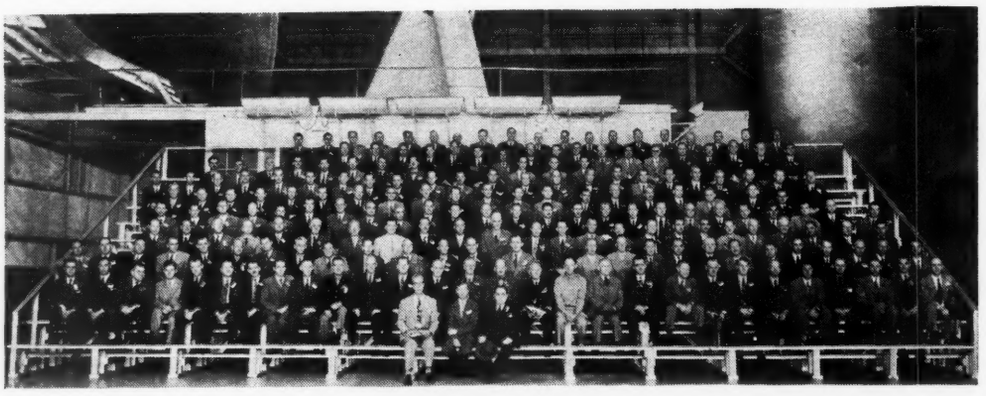
Oct. 23-25: Second Annual Arizona Aviation Conference, Phoenix.

Oct. 24: IAS Air Transport Meeting, Statler Hotel, Washington, D. C.

Nov. 7-8: SAE National Fuels & Lubricants Meeting, Mayo Hotel, Tulsa.

Dec. 2-4: SAE National Air Transport Engineering Meeting, Edgewater Beach Hotel, Chicago.

Dec. 17: IAS Wright Brothers Lecture, N. Y. C.



NACA REVIVES OPEN HOUSE

Gathered here in Langley Field Memorial Aero Lab are nearly 200 of nation's topflight aviation engineers, officials, and observers—guests of NACA during recent 15th annual tour of famed research center's facilities. First such inspection permitted since 1939 particularly pointed up work being done in fields of supersonic flight. NACA technicians predicted that 750-mph.-plus craft would be flying sometime this year.

the bomb develops, its unearthly pressures, and the weird nuclear effects. Secondary interest will be in the damage inflicted on the steel fighting ships. (Also see feature, "Crossroads Critique," page 38.)

Service Merger Still Halted

Even though bill to merge Army, Navy, and Air Forces under a single Department of Common Defense has been favorably reported by Senate Military Affairs Committee, a bitter back-stage opposition may now prevent action by current 79th Congress. Pres. Truman's order to Navy to stop its obstructive tactics cannot be wholly effective.

A compromise bill, to preserve independence of War and Navy Departments by creating a new Department of Air, has been offered. Navy is expected to win some sort of compromise in the end.

Air Policy Bill Hits Hurdle

Sen. Hugh Mitchell's bill for creation of a National Air Policy Board to maintain peacetime air power is now threatened by a jurisdictional fight between Senate Commerce Committees. The bill itself is not controversial, since it merely commits the government to make a study. Some observers declare the $15,000 and three months time asked by Mitchell are insufficient.

Most Surplus Craft Sold

Bulk of war surplus airplanes, salable for civilian use, have been disposed of. Public opinion strongly opposed scrapping expensive combat equipment, but this reaction is now easing off, and thousands of craft, massed at Albuquerque, N. M., Clinton, Okla., Kingman, Ariz., Ontario, Cal., and Walnut Ridge, Ark., will be broken down. Planes at each field would be sold in one lot to one purchaser, who could represent a cooperative. They would yield 210,000,000 lb. of aluminum. Maintenance of the dead airplanes is costing War Assets Administration too much, officials said.

Three hundred surplus Fairchild PT-23s were sold recently for $590 to $1,275 each; more than 500 remain. WAA says Douglas C54-As are de-allocated and may be bought at $75,000 each, same for Convair PBY-5As, $26,000 each. Beech AT-11s, now de-allocated, can be bought at storage depots for $17,500 to $25,000 each.

★ SPOT CHECKING ★

Three K-type airships have been purchased by Douglas Leigh Sky Advertising Corp., which plans to fit them with electric light signs of running letter type, stated to be visible at least 5 mi. from 2,500 ft. First contract is with MGM for advertising concern's motion pictures.

Twelve awards, totaling $9,000, are being offered to those engaged in design, manufacture, or construction of any type of aircraft, and mechanical or structural parts thereof, by Lincoln Arc Welding Foundation. Called "Design For Progress" program, contest promotes study and preparation of papers on design, construction, application, and use of arc welding. Further details on competition, which closes June 1, 1947, can be had from Secretary, James F. Lincoln, Arc Welding Foundation, Cleveland 1, Ohio.

AAF initiated tests at Muroc Lake to determine flight potentialities of Messerschmitt Me-163B rocket-propelled fighter. Program covers three phases: Gliding, powered flight, and powered takeoff. A Boeing B-29 is to tow craft to desired heights for flight tests. Rate of climb up to 40,000 ft. will also be investigated.

CAA has a new ground instructor rating for certification of Link trainer operators. Applicants must pass a written examination. All CAA certificated schools offering instrument flying training must give Link instruction.

NAA announced sanction of National Air Races planned at Cleveland over Labor Day weekend, Aug. 30 to Sept. 2. Agreement was signed by William R. Enyart, NAA pres., and Frederick Crawford, pres. of Races and of Thompson Products. First N.A.R. since '39 will feature Thompson Trophy speed race, Bendix Trophy cross-country derby, and other special events. Benjamin Franklin is mgr.

Just revealed is fact that a Boeing B-17 towed a Bell P-39 fighter 1,940 mi. non-stop on Sept. 1, 1942, a record still standing. Experiment proved feasibility of towing tactical aircraft.

Deadline for annual inspection of aircraft has been set at July 1, 1946. Planes not inspected within 12 mo. preceding this date will be considered unairworthy and will be grounded. Flying aircraft after this date without an inspection will subject owners or operators to penalties. Check must be made by a CAA inspector, following required periodic 100-hr. inspection by a certified A & E mechanic.

A study of U. S. education system, and its relation to military and commercial aviation needs, has been started by Air Power League, and this will be followed by grant of a series of scholarships. Initial survey, expected to take from 8 to 10 mo., will be directed by C. F. Kettering, v-p. and director of research for GM.

Navy version of Lockheed Constitution is expected to be completed this summer. Military model is to be fitted with four P&W R-4360 Wasp Majors, bettering 3,500 hp. each, giving craft an estimated 300-mph.-plus top speed. Wing span is to be 200 ft., and length 155 ft., with gross weight planned at about 90 tons. Plane will be capable of transporting 175 men in its twin decks. Commercial version is to carry between 90-100 passengers with luxurious accommodations.

Electrically heated rubber facings for preventing ice-formation on intake cowls of jet planes are now being produced by B. F. Goodrich. Company states facings also serve as effective anti-abrasion shoes.

A nationwide contest to encourage safe flying by students is underway, sponsored by Piper and some 1,000 company dealers. A specially designed Piper Cub trophy will be presented by each dealer to pilot on his field who, in six months, flies greatest number of hours without any kind of accident.

A novel method of steering an aircraft carrier was developed by "Midway" C.O. Two rows of Vought F4U-4 Corsair fighters, facing each other, are lashed down along forward flight deck. Then, by turning over planes' engines at full gun simultaneously in either row, carrier's bow can be swung in desired direction, thus enabling ship to turn in a comparatively short radius.

N. Y.-Washington record was clipped by a Lockheed P-80A, which made 226-mi. hop in 29 min. 15 sec.

Erratum: In our Nov. 1945 Aviation (Abroad page), Keith and Ross Smith were flyers credited for 63-hr. England-Australia flight in a Lancastrian. Actually, Ross Smith died some years ago, hence mentioning him in connection with this flight was incorrect.

During recent meeting of N. Y. State Aviation Council at Westchester Country Club, talks were given on major airline and feederline topics. Ralph S. Damon, AA pres., urged opposition to proposed state regulations governing major carriers, stating Federal government should maintain reins. C. S. Robinson, regional airline operator, spoke of need for small lines to get off beaten track and service more communities. Following meeting, new VHF instrument landing equipment for personal flyers, developed by Federal Telecommunication Lab., the research unit of International Telephone & Telegraph, was demonstrated at nearby airport.

CAA marked 20th anniversary of federal regulation and promotion of civil aviation. Pres. Coolidge signed Air Commerce Act on May 20, 1926, vesting in Aeronautics Branch, Commerce Department, first specific governmental responsibility for aviation. That year a traveler could cover 8,404 air route miles. By end of 1946, routes of U. S. airlines will extend approximately 150,000 mi. In 20 yr., certificated pilots increased from 1,572 to some 340,000.

★ PLANES AT WORK ★

Nearly 5,000 lb. of top grade Douglas fir paneling was flown from Portland, Ore., to Galveston, Tex., aboard a National Skyway Freight Co. converted Douglas C-47. Taking only a day, flight made it possible to accomplish delivery of 3,500 board-ft. in time for use in an auction

An airborne service unit designed to implement Audio Devices' new program of accelerated customer contact and technical educational service, was inaugurated at La Guardia Field, N. Y. Using a specially-equipped Waco cabin plane, firm plans to send a technician and sales or service material to all parts of country, as needed.

Cargo of new S-40 Hallicrafters radio receivers was rushed to N. Y. dealers from Chicago aboard an AA Douglas DC-4 in 3 hr. 42 min. in response to heavy demand.

Emergency shipment of 18 gasoline-drive generator units was flown from N. Y. C. to Chicago in 5 hr. during recent coal strike in order to provide electric facilities in schools, hospitals, and other public institutions in that

"If we'd made this radiograph sooner...

...we'd have saved $30,000"

A manufacturer of valves, whose foundry technic seemed "okay," decided pilot radiographs weren't needed. But when machining was done and the valves assembled, enough were found defective to cause a loss of many thousands of dollars.

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Order-jammed foundries get a welcome production spurt when radiography shows how to get into sound casting production fast. High-value, high-volume machine shops operate at rock-bottom cost when radiographic inspection keeps internally unsound castings off the production line.

Welding gains acceptance . . . new markets . . . higher volume . . . because radiographs prove weldments sound.

And these are only a few high spots in radiography's list of industrial functions. You can find more—if you look for them—right in your own plant. Why not get together with your radiographer or the local x-ray dealer and see if you are missing any chances to make radiography pay extra dividends? Or write to

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Rochester 4, New York

Radiography

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Exhaust Equipment from window or wall fans to spray booths.

Service Equipment for lubricating, cleaning and degreasing.

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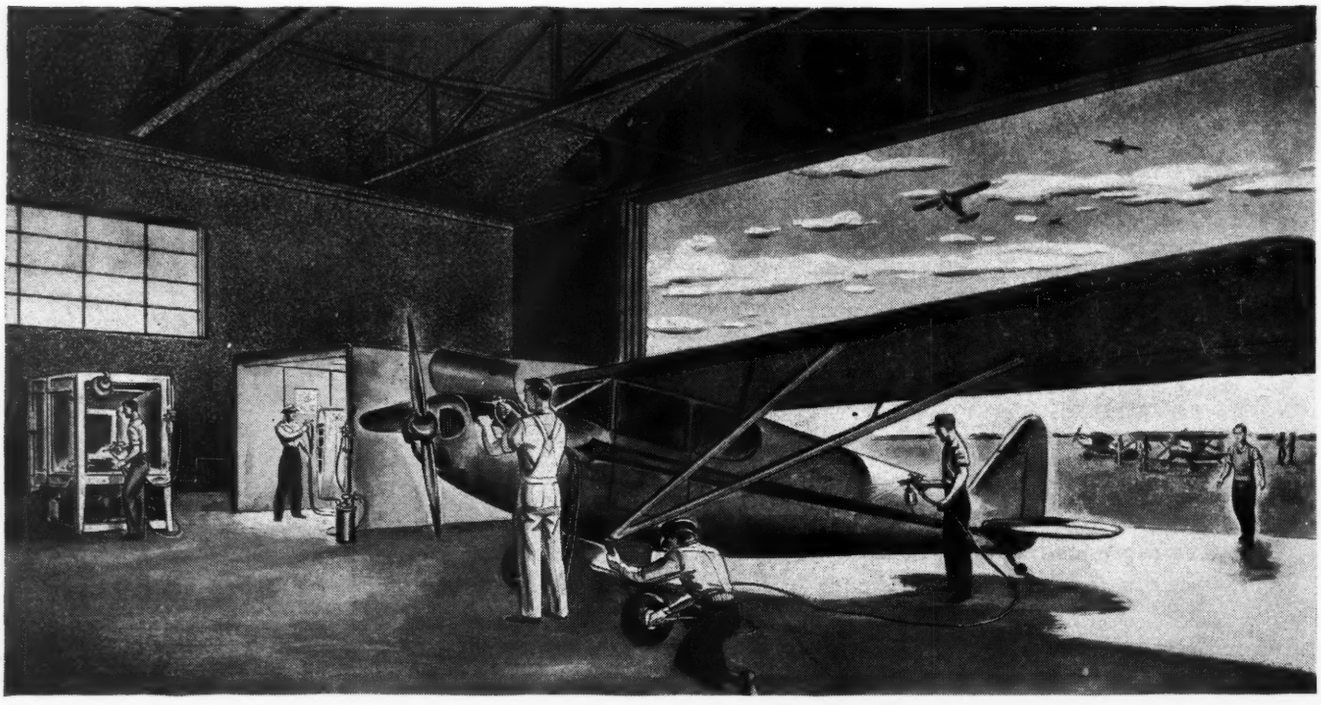
Hose for air, oil, gasoline and pneumatic tools.

Hose Connections—Removable and Reusable, Quick Detachable Types.



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SPRAY EQUIPMENT
EXHAUST SYSTEMS
AIR COMPRESSORS
HOSE & CONNECTIONS

area. Carrier was Air Cargo Transport.

In order to keep mill schedules going to meet prior commitments for Fall couturier trade, six bales of raw silk valued at $8,500 were flown cross-country in 10 hr. via TWA Lockheed Constellation, after arrival from China. Sea shipment had been delayed by typhoons, and flight helped make up for lost time.

Largest combined air shipment of farm machinery was started by cargo planes of four airlines, with planes rolling right up to doors of former Willow Run bomber plant and loading up with Graham-Paige Rototillers for delivery to all parts of country. In first haul, ten Douglas DC-3s took off in succession to carry combined load of 200 machines to ten widely separated points. Airlines participating are EAL, TWA, Slick Airways, and U. S. Airsped Co.

Largest single air shipment of flowers was made from San Francisco to eastern markets in time for Easter. TWA and Slick Airways split 300,000-flower load among three Curtiss C-46s and five Douglas DC-3s.

Tons of fresh foods and perishables were flown into Alaska by Douglas DC-3s during recent longshoremen's strike.

Fresh fish and seafood were flown by seven airlines for test sales to A & P Supermarkets during Lent. New iceless insulated paper containers were utilized, weighing only one-tenth of their contents. Flights were made in cooperation with Wayne University's air cargo research program.

All-America Football Conference signed a year's contract with UAL to provide air transportation of member teams for regular games, training trips, and exhibition contests. Charter agreement amounts to about $250,000.

A new "high" in aerial forest fire observing was revealed recently by press. A New Jersey flying fire warden reported that he actually spotted an alleged firebug at work, notified forest fires hq., and had suspect intercepted.

Regular weekly overnight air shipment of women's clothing from N. Y. C. to Los Angeles was inaugurated by Sears Roebuck. Carrier is National Skyway Freight, and each flight will consist of about 5,000 units.

Cab Calloway purchased a surplus Douglas C-47 and plans to use craft for touring his band. Plane is to be soundproofed to permit rehearsing en route.

★ CALLING NAMES ★

James E. Boyce has been appointed Lockheed's eastern regional mgr.

James P. Cunningham has been named Luscombe v.-p. in charge of production.

Douglas appointments: **Fred W. Herman** has been made plant mgr. Long Beach, to succeed **A. C. Wallen**, who was made production mgr. at Santa Monica; **Charles W. Faull** has been named Dayton, Ohio rep., succeeding **C. W. Hamilton**, who has been assigned as sales development mgr. at Santa Monica.

Thomas Wolfe, formerly v.-p. of WAL, has joined United-Rexall Drug as asst. to pres.

Ellis Emmons Reed has been made pub. rel. mgr. for Air France in North America.

C. R. Smith has been elected pres. of American Overseas Airlines, succeeding **Sumner Sewall**, now with War Dept. on undisclosed assignment.

UAL appointments: **W. A. Patterson** was re-elected pres., **W. R. Thigpen** has been named special asst. to pres. with hq. in Seattle, **M. P. Bickley** has been appointed mgr. cargo sales with hq. in Chicago, **Gordon D. Logan** has become district traffic & sales mgr. at Phila.

Col. Franklin C. Wolfe has been appointed gen. sales mgr. for G. M. Giannini, Pasadena.

Gen. Carl Spaatz has been appointed a member of NACA, succeeding Gen. Arnold on Committee.

Donald E. Wood has been appointed exec. asst. to v.-p. and gen. mgr. of TACA Airways with hq. in Miami.

K. R. Ferguson has been elected member of board of directors of Aeronautics Radio.

PCA elections: **C. Bedell Monro**, pres.; **James H. Carmichael** exec. v.-p.; **J. J. O'Donovan, Luther Harris** and **Robert J. Wilson** v.-p.; **R. G. Lochiel** v.-p. & treas. **Robert H. Ames** has been named asst. to dir. pub. rel.

Joseph A. Young has been appointed operations mgr. for C&S.

Wesley R. Bunker has been named v.-p. for American Air Express.

Franklin D. Walker has joined Fairchild Engine & Airplane's pub. rel. staff as editor of "The Pegasus".

Col. Weldon E. (Dusty) Rhoades has been appointed director of Air Navigation-Traffic Control group of ATA.

Nicholas Craig has been appointed sales mgr. for Panagra with hq. in N. Y.

Col. Robert L. Copsey has been named state aviation director for New Jersey.

Holden A. Evans, Jr., has been appointed secy. of New York City Airport Authority.

Ralph G. Lockwood has been named Chief of Maintenance & Salvage, Office of Aircraft Disposal, WAA.

Colonial Airlines elections: **Sigmund Janas**, pres.; **Edward S. Ridley**, v.-p.; **Branch T. Dykes**, v.-p. in charge of traffic; **K. Hamilton**, secy.

CAA appointments: **Harry G. Tarrington** named chief Div. of International Activities, **Howard W. Sinclair**, appointed asst. administrator for aviation training.

L. C. Doolittle has been named sales mgr. of aviation div. of Weatherhead Co.

Milton L. Fitch has been elected pres. of Worcester, Mass. Chapter, NAA.

Croil Hunter, pres. & gen. mgr. of NWA, has been appointed national chairman of Bong Memorial Foundation.

Rudolph F. Lemeke has been appointed service mgr. at Pacific Airmotive's Oakland hq.

United Aircraft elections: **William P. Gwinn**, gen. mgr. of Pratt & Whitney has been made v.-p.; **Rex B. Beisel**, gen. mgr. of Chance Vought div. named v.-p.; **Lauren D. Lyman**, in charge of pub. rel., has been made v.-p.

Zac D. Dunlap has been named adv. mgr. of Pacific Airmotive, with hq. at Glendale, Cal.

Royal Jordan was named European region traffic mgr. of TWA.

Mrs. Arlene Davis, woman flyer, has been appointed chairman of national Wing Scout Advisory Committee.

Jack Frye has been re-elected pres. of TWA for thirteenth consecutive yr.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

There's one wide field in aviation that isn't regulated. It's parachute jumping. You just buy or borrow a chute, any kind, and jump—if you want to. Schools are starting; it's a wonderful sport. But hurry—because CAA does have a rule against throwing "objects" from planes over populous areas, and now lawyers are debating whether a person is an object, or something else. There'll be a law.

To the Powers-That-Be goes The Stubblefield Award this month. Selig Altschul now CAB analyst, did an essential writing job on one of the U. S. Strategic Bombing Survey reports—and then had to pay the Public Printer 50¢ to get a copy of it.

Mystery: Post Office representatives now sit in CAB hearings on every application for airmail air routes. Why they haven't been sitting in there all these past years nobody can explain.

Airport congestion is an increasingly serious threat to growth of all civil aviation, and the new federal aid, along with surplus fields, won't entirely dispel it. Search for means to eliminate long ground runs—takeoff assist, landing arrest, and the like—is intensifying in order to permit operations in less space.

THERMAL RIDERS SET ENDURANCE RECORD

Paul A. Schweizer (left), gen. mgr. of Schweizer Aircraft Co., glider maker, congratulates Richard Powell and Franklin E. Hurtt after they stayed aloft 10 hr. 9 min. over Harris Hill, Elmira, N. Y. Previous mark of 9 hr. 17 min. was made by Mr. Hurtt and Mr. Schweizer. In making the new endurance record, subzero temperatures and icing conditions were encountered, and landing was made in a snowstorm. Craft is SGU 2-22, all-metal-structure utility two-placer which company plans to put into production soon.

★ CAA TYPE APPROVALS ★

Aircraft: Cessna 120 and 140, ATC 768. Airworthiness Certificate: Douglas UC-67 and B-23, 2-576.
Engines: Franklin 6V4-178-B31, ATC 244; Lycoming 0-435-11, ATC 228; P&W Twin Wasp D3, ATC 230.
Propellers: Hartzell 44K15005 and 8516E, ATC 837; Sensenich 73KE and 73KR, ATC 838; U. S. Propellers 43K10107 and 72AC, ATC 839; Stearman SQ-200, ATC 840; Curtiss C532S-E, ATC 735; Hamilton Standard 22D, ATC 736.

FIRST AIRLINE to announce the purchase of the Sperry A-12 Gyropilot with Automatic Approach Control is United Air Lines . . . for its new Mainliner "230's"

NOW! . . . SPERRY MAKES AVAILABLE

➡ Automatic approach control

AS A STANDARD ACCESSORY TO THE SPERRY A-12 GYROPILOT*

● Following years of intensive development and thorough flight testing, Sperry is now producing an Automatic Approach Control as an accessory to the Sperry A-12 Gyropilot.

With this equipment, signals received from the Cross Pointer Meter are interpreted in terms of turn and climb and descent which the A-12 Gyropilot uses in guiding the aircraft automatically to the landing beam and keeps it there without oscillation or hunting. The degree of stabilization provided by the A-12 Gyropilot at approach speeds makes the Automatic Approach Control highly effective.

The Automatic Approach Control is being produced with the same integrity of design and dependability of performance that characterize the Sperry A-12 Gyropilot.

Incorporating this Automatic Approach Control as a standard accessory to the Sperry A-12 Gyropilot is a notable forward step toward completely automatic flying. It permits development of new operating techniques which will result in improved schedule reliability.

Upon request our Aeronautical Department will be glad to supply further information.

*TRADE MARK REG. U. S. PAT. OFF.

Sperry Gyroscope Company, Inc.

GREAT NECK, NEW YORK • DIVISION OF THE SPERRY CORPORATION

LOS ANGELES • SAN FRANCISCO • SEATTLE • NEW ORLEANS • CLEVELAND • HONOLULU

GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION

Plan Huge Supersonic Research Center; Air-Status Vigil in New Procurement Bill

. . . Free AA to buy CV-240s . . . Project new artillery plane . . . Re CV, UAC Terminations . . . AIA, CAA tackle problems . . . Engine output reported . . . B-29 in cosmic ray check.

A supersonic research center, to cover 100 sq. mi. with wind tunnels to test full-size aircraft at high Mach numbers, and reproducing stratospheric conditions, is planned for location in the West, preferably near the Grand Coulee power plants on the Columbia River, State of Washington.

Army Air Forces initiated the half billion dollar project in cooperation with the NACA. Undoubtedly the Navy's air arm, the aircraft industry, and the National Science Foundation to be established by Congress, will participate. Debate will involve the proposed Army-Navy merger, and final authorization is not expected for a year or two.

It is estimated the fans, to develop wind tunnel air currents exceeding 1,000 mph., will require as much as 1,000,000 hp., a large portion of the total generated at Grand Coulee. NACA's engineers have been in the Big Bend region recently, making preliminary surveys of sites.

Air-Status Vigil Features New Procurement Bill

A bill revising the aircraft procurement system is nearing completion in Congress. Measure requires the Secretaries of War and Navy to make frequent reports on their departments' aviation activities, which will be closely watched by Congress. Each Secretary would have broad powers over experimental work in the public interest.

The bill stirs consideration on the question whether Ordnance or the air arms should have charge of guided missile development. Should "uninhabited" missiles largely replace airplanes for future bomb assaults—and then be handled by ground forces—the status of military aviation, as such, would be affected.

Final form of the aircraft procurement bill may be importantly changed if a separate Air Force results from the proposed Army-Navy merger.

Free AA to Buy CV-240s

CAB has withdrawn an order which would have prevented American Airlines from buying $18,000,000 worth of airplanes from Consolidated Vultee. After the Board had contended that both companies were controlled by The Aviation Corp., and that therefore the purchase was illegal, the order was vacated when Avco reduced its holdings to less than 4% of voting stock outstanding. AA was freed to consummate purchase from Consolidated Vultee of 100 Model 240 transport planes.

Project New Artillery Plane

Renewing its interest in so-called "safety" planes for artillery-fire observation and for other liaison work, Army Artillery, through the Air Forces, which procures its planes, has received proposals on a new design, from Consolidated, Boeing, Piper, Bellanca, and Ludington Griswold.

Coming in response to a general invitation, these proposals are being examined at Wright Field, and awards are expected soon. CAA and AIA cooperated in suggestions to Air Forces that military liaison and civilian lightplanes have common design features.

Re CV, UAC Terminations

In termination settlements, Air Forces has agreed to pay Consolidated Vultee $83,000,000 on a contract which called for delivery of 1,213 B-32 bombers, cancelled after V-E Day. AAF had paid $75,000,000 for 114 delivered planes.

United Aircraft has accepted $52,000,000 on terminated Army and Navy contracts totaling $723,000,000. Additional $30,000,000 was agreed on for future claims of subcontractors. All of the contracts were Navy, some delegated by the Army. In March, BuAer had outstanding 1,437 terminations totaling $2.5 billion.

AIA, CAA Tackle Problems

First joint engineering conference of the Aircraft Industries Assn. and CAA to deal solely with personal aircraft was recently held in Washington. Problems in certification, design requirements, flight testing, and the like, were discussed.

Specific subjects: Data needed to prove eligibility for certificate; delays in approval of design changes; manufacturers' designated inspectors and engineering representatives; delays in export certificates; waiver of tests flying before export; what countries we have reciprocal agreements with; CAR 17 and the cost of instruments; international airworthiness agreements; and delays in transfer of title to purchaser. Conclusions had not been reached at this writing.

Engine Output Reported

AIA announced that 256,915 military aircraft engines were produced in 1944 and 109,695 in 1945. For Jan. 1946, total was 121; Feb., 140; and Mar., 135. In addition, 1,203 military jet engines were produced in 1945.

Civil aircraft production in 1945 was 2,047 units. Totals of military aircraft engine production in each of six years, beginning 1940, are given by AIA. Monthly totals, 1945, are reported for both piston and jet engines, with breakdown by hp. and thrust, respectively.

Labor turnover in the aircraft industry in 1945 is stated in percentages, varying from 4.8 to 51.1, by months.

B-29 in Cosmic Ray Check

A series of experiments is being conducted by Guided Missiles Branch of AAF Research & Engineering Div. to determine the effect of cosmic rays on various chemicals and metals. A Boeing B-29 carries specimens and instruments at altitudes of 25,000 and 35,000 ft. National Geographic Society is participating to determine cosmic rays affecting the earth.

★ INDUSTRY MEMOS ★

Republic booked order for 20 Rainbow transports for AA at cost of $1,100,000 each. PAA raised its Rainbow order to 18, at $1,125,000 each.

Grumman expects to turn out 35 Mallard amphibians this year, costing about $90,000 each. Estimated market for new craft is placed at 250 units. Company temporarily stopped taking orders on aluminum canoes. As for production on latter item, goal has been raised to 10,000 units.

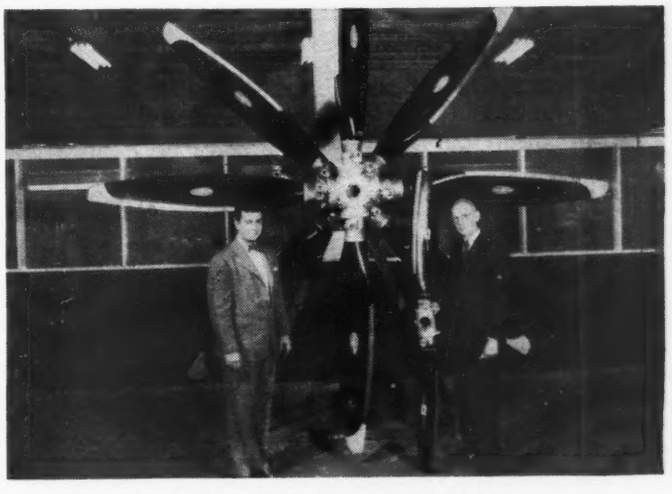
Douglas is readying a new close-tolerance cabin refrigeration control unit for cargo planes designed to maintain temperature stability throughout long flights and cut spoilage losses in shipment of perishables.

All new Ercoupes are being fitted with a newly designed landing gear. Based on same knee-action principles as former Ercoupe gears, following are features: Forged aluminum alloy articulating brakes, Goodyear single-disk brakes and wheels, 6.00x6 wheels and tires, and induction-brazed steel oleo structure.

Boeing went into quantity production of its new Model 417 feederliner. Powered by two 800-hp. Wright Cyclones, it is designed to accommodate 20-24 passengers. Craft, to be of high-wing layout, will utilize retractable tricycle landing gear. . . . Company retained Walter Dorwin Teague organization to assist with interior styling of Stratocruiser, for which company has $56,000,000 order backlog.

Piper started production of new PA-12 Super Cruiser (formerly designated J-5), with backlog on this type estimated as 5,086 units.

C-W Propeller Div. is busy fulfilling orders for electrically con-



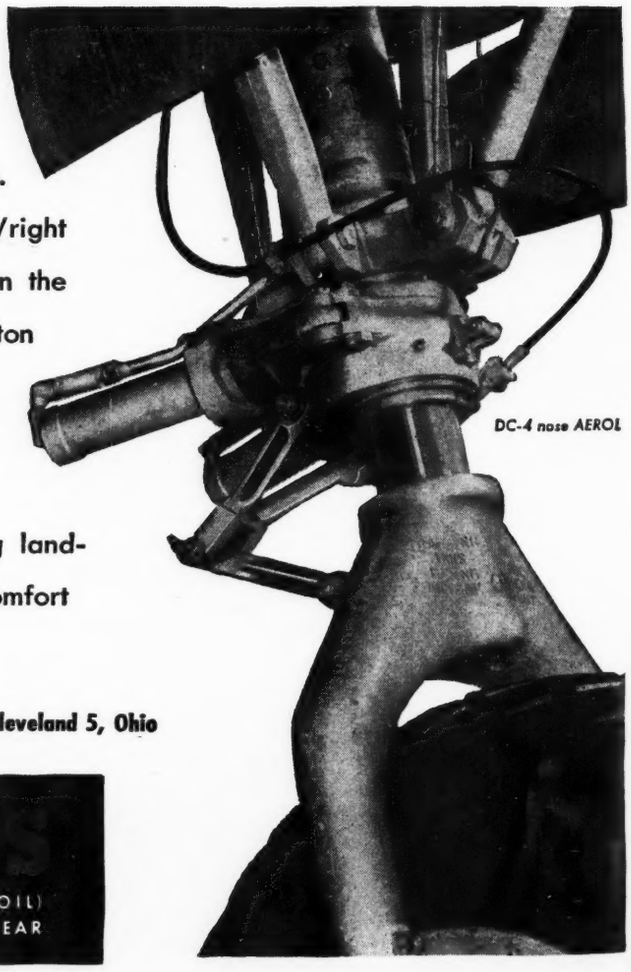
AEROMATIC'S NEW MULTI-BLADER

Towering over Paul F. Hakethal (right), chief engineer, and Sid Fehan, manager, is Aeromatic's giant new 8-blade contra-rotating propeller developed for 2,500-hp. aircraft engines. Especially notable: Prop's design dispenses with need for conventional hydraulic or electric pitch changing, this operation being accomplished by natural physical forces during rotation. Blades are of high-strength plastic-bonded plywood covered with hard Aeroloid plastic. Mr. Fehan holds small 200-hp. Aeromatic prop for light planes. It's designed on same pitch-change principle. (J. H. Schaefer & Son photo)

AEROLS

SHOCK-PROOF DIXIELINER LANDINGS

Luxurious DC-4s have recently been added to the fleet of Chicago and Southern Air Lines. Their Dixieliners are powered with the new Wright Cyclone 9HD, making them the fastest DC-4s in the world. Travel time between Chicago and Houston has been cut two hours and twenty minutes. Like other DC-4s, these Dixieliners are equipped with Cleveland Pneumatic nose and main leg AEROLS. By efficiently absorbing landing shock, AEROLS contribute greatly to the comfort and safety of these outstanding planes.



DC-4 nose AEROL

THE CLEVELAND PNEUMATIC TOOL CO. • Aircraft Division • Cleveland 5, Ohio

AEROLS

*PNEUMATIC-HYDRAULIC (AIR-OIL) SHOCK ABSORBING LANDING GEAR

trolled reversible pitch props for AA, AOA, NWA, PAA, TWA, Air France, KNILM, and Swedish Airlines.

Commonwealth expects to achieve production of ten Skyrangers daily this month, and ten Trimmer amphibians daily by Sept. Output of latter is slated to reach 25 daily by year-end.

Hamilton Standard is now in production of small two-blade Hydromatic props in 450-600-hp. range. Installation tested on Beech 18 is said to have given craft 100-fpm. increase in climb, and raised absolute ceiling by 2,400 ft.

Permoflux Corp. of Chicago states it has constructed truly echo-less chambers for testing efficiency of radio speakers. Designed to absorb sound waves, installation consists of two rooms, one suspended within other and set on damping pads.

With Departments of State, Post Office, and Commerce reported studying feasibility of new efforts to establish lighter-than-air transocean services, Goodyear Tire & Rubber Co. announced plans to build a fleet of super-dirigibles to carry passengers and cargo which, they said, could be put into operation within 5 yr.

Total of 2,378 new aircraft engines ranging from 65 to 1500 hp., declared surplus by Navy, were placed on sale to first comers by War Assets Adm. Stored at several Navy installations, plants include Continental, Lycoming, Warner, Jacobs, Ranger, Wright, and Pratt & Whitney, in lots of a few to several hundred each.

★ FOR THE RECORD ★

Pacific Aircraft Sales Co. has reactivated Southern Cal. hq. in Pacific Airmotive Corp. hangar at Lockheed Air Terminal.

Faircraft Corp., Dansville, N. Y., is new aircraft maker formed by ex-C-W and Bell engineers, who plan to build a two-place 100-hp. personal plane to sell for $3,000.

Wright Aero contracted to sell to Aero Holding Co. of N. J. its Plants 1 and 2 in Paterson, N. J.

Airborne Instruments Lab., Mineola, L. I., is new concern formed by electronics engineers from Harvard, MIT, and Columbia, to develop new products and procedures for airlines and services. No manufacturing is contemplated.

Gulfair is new organization planning to merchandise products adaptable to air transportation through use of commercial airlines and company's own fleet of cargo planes. Business offices are in Cravens, Dargan Bldg., 1205 Holman St., Houston, Tex.

Piasecki Helicopter Corp. is new name for former P-V Engineering Forum, Inc. Company will continue helicopter activities.

Lockheed established a supply and overhaul base at Linden Airport, Linden, N. J., to supply spares and facilities for overhaul and repair of Constellations. Walter McGinty is in charge.

Douglas moved El Segundo Engineering Div. back to El Segundo production plant adjoining Los Angeles Airport. Div.'s former quarters are to be used by CAA's Sixth Region hq.

Eclipse-Pioneer Div. of Bendix appointed Aviation, Ltd., 3483 Park Ave., Montreal, as Canadian sales and service rep. for div.

Colgate Aircraft Corp., Amityville, L. I., N. Y., purchased for occupancy former Grumman building at 14th St., south of West Hoffman Ave., in Lindenhurst, L. I., and plans to use space for augmenting present production.

Jones, Page & Gillies inaugurated nationwide service as aviation consultants, with hq. at 1227 19th St., Washington 6, D. C.

Wings Club moved its quarters to Hotel Biltmore, N. Y. C.

NATA opened a Washington office at 1365 Connecticut Ave. for liaison with government agencies for fixed base operators.

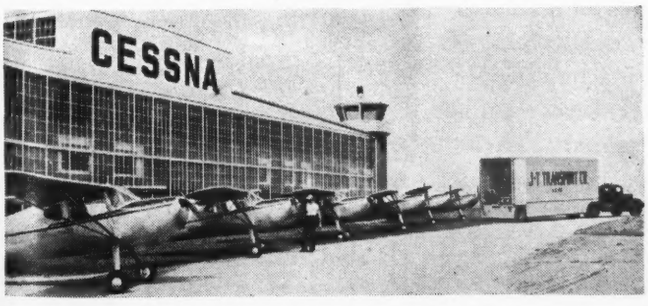
Kellett, planning to expand operations to double wartime peak, has arranged to lease 420,000-sq. ft. WAA-owned surplus war plant at North Wales, Pa.

Western Electric leased Fairchild plant at Burlington, N. C., for 3 yr., with option to purchase, and plans to locate there operations now at Kearney, N. J., and Baltimore, Md.

Atlantic Aviation, sales and service operator, began activities at Baltimore Municipal Airport.

Timken Roller Bearing is testing a new method for achieving new perfection in metallurgy and geometry of bearing making. Employed is a pilot plant at Zoarville, Ohio.

New Accounts: Douglas appointed J. Walter Thompson agency to handle domestic advertising, and Dorland International-Pettingell & Fenton to handle foreign account . . . East Coast Airlines appointed Moore & Hamm as its agency . . . BOAC named Cecil & Presbrey to promote new program.



MASS SEND-OFF BY CESSNA

To supplement firm's flyaway schedule, Cessna is delivering a portion of its Model 140 production via trailer trucks. Careful study showed six planes can be stowed in vehicle depicted, resulting in considerable saving in transportation charges.

Easy-to-Use Stainless Tubing Data

At Your Fingertips

The Carpenter Stainless Tubing Slide Chart gives your engineers easy-to-use data on Mass Velocity Constants, Velocity Constants, Cross Sectional Areas and Sq. Ft. Surface per Lineal Foot of Tube . . . for sizes 3/8" to 2" O.D.

This Slide Chart also contains information of physical properties of various types of Stainless Tubing, and data on theoretical bursting pressures. A note on your company letterhead will start your copy on its way.

Mail Your Request to

THE CARPENTER STEEL COMPANY
Welded Alloy Tube Division
Kenilworth, N. J.

Carpenter
WELDED
STAINLESS TUBING

H. D. INGALLS... *veteran maintenance chief American Airlines pre-war, and for ATC at Northeast Airlines during the war... now General Manager of the new Bluegrass Airlines, is making an extraordinary operating record with his "progressive maintenance."*

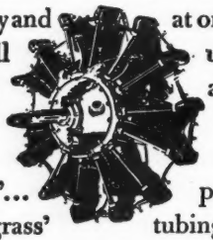
Burning daylight in Kentucky!

With only two converted Cessna transports powered by wartime Jacobs engines... Bluegrass Airlines gives Kentucky statewide service, links seven cities with regularly scheduled week-day flights, logs 960 miles daily and 5760 miles per week! And will shortly add Sunday operation with the same equipment!

How do they do it?

"Progressive maintenance"... the system developed by Bluegrass' headman H. D. Ingalls while in charge of ATC maintenance on Northeast lines during the war. Bluegrass' trim planes on alternate days end their trips at Bowling Green, the company's base, where a veteran AAF crew checks and overhauls some portion of plane and equipment each night on a rotating schedule. The ships are kept in service without the loss of flying time.

The Jacobs R755-9 engines fit into this tight operation program like web feet on a duck... maintain schedules at only 1850 rpm, 58% capacity... use as little as 14 gallons of fuel and only 1 quart of oil per hour.



The compact rear case and unique accessory drive unit permit quick, easy inspection of tubing, wiring, control linkages, and facilitate engine change, reduce line maintenance details. For dependable, low cost performance with minimum maintenance, Ingalls rates the R755-9 as one of the most satisfactory engines he has ever known... believes that his current 650-hour period between majors could be extended without undue wear or safety infringement.

Today the new R-755A is an even better Jacobs... because of intensive research, improved metals, quantity production experience... weighs no more, but delivers 33% more power — 300 hp at 2200 rpm — is more sparing of fuel and oil... is the most efficient non-supercharged radial in its power class available today... Ready for delivery now, too! Inquiries invited ... Jacobs Aircraft Engine Company, Division of Republic Industries, Inc.

JACOBS • **Pottstown, Pa.**

Division of Republic Industries, Inc.

Senate Body Scouts Bermuda Pact Legality; State Three Points for Accord With Russia

. . . Balkan air link sought . . . Push for transport agency . . . Fact-finders vs. strike . . . Mergers and expansions.

In a 14-to-1 vote Senate Interstate Commerce Committee challenged legality of the Bermuda agreement between the U. S., Britain, and France. This pact was undertaken to arrange schedules and rates between the three countries, and to open military bases in the Atlantic for commercial aviation.

Committee move means that the Bermuda agreement will not be effective until the controversy is settled. CAB is not subject to criticism, because it merely assisted the State Department in negotiations. The latter submitted the final document, as an Executive action, to Senate Interstate Commerce Committee for comment.

If Congress decides the agreement is a treaty, it will have to be confirmed by a two-thirds vote of the Senate.

State Three Primary Points For Accord With Russia

During meetings with Russian officials this summer, the U. S. State Department will (1) attempt to obtain rights to terminals in Leningrad and Moscow, (2) will ask benefits of the "Fifth Freedom," and (3) will propose that there be no limitation on schedules.

Moves comprise second step following Soviet agreement to discuss exchange of air services between U. S. S. R. and U. S. (page 125 May AVIATION). Considerations in the proposed billion-dollar loan to Russia are seen involved.

The United States-Russia agreement would be fashioned after the Anglo-American-French Pact of Bermuda. American Overseas Airlines has been assigned the proposed route to Moscow.

Balkan Air Link Sought

The U. S. hopes to extend airlines into the Balkans and is opposing Russian plans to set up monopoly airlines there. This subject will come up in discussion of the proposed exchange of services between the Soviet and U. S.

Russia, meanwhile, is regarded as certain to oppose establishment by TWA of a cooperative airline system in Italy. Italian government approval also seems doubtful because of Russian and British opposition. British object mainly because BOAC is frozen out.

Push for Transport Agency

Increasingly exerted is pressure by surface transportation for "integration" of all transportation under one federal agency, as House Interstate Commerce Committee prepares to investigate the economic inter-relation between rail, water, highway, and air services.

Sea-Air Committee is demanding air auxiliaries for shipping. Air Transport Assn. sent a recommendation to the House Committee that air transport continue under independent ownership, and under separate regulation.

The statement, by Emory S. Land, ATA pres., also asked that further multiple state taxation be halted, and that interstate airlines be subject only to federal authority.

Fact-Finders vs. Strike

After months of controversy between the Air Line Pilots Assn., and the airline wage negotiating committee, over pay increase for flying 4-engine equipment, ALPA threatened to strike TWA's 28,270-mi. domestic and foreign route system. Efforts toward mediation and arbitration having failed, the National (Railway) Mediation Board reported an interstate commerce emergency to the President.

Appointed was a fact-finding board, which must recommend terms of settlement within 30 days, after which both parties in the dispute must refrain from strike or lockout for 30 more days. The fact-finders recommendations will cover all 13 airlines operating, or planning to operate, 4-engine planes.

Mergers and Expansions

PCA urged at hearings that CAB approve a merger with Northeast Airlines, already approved by stockholders of both companies. PCA contends increase in resources and credit would permit complete development of traffic potential. . . . Another step in airline expansion was application by UAL for extension from Omaha, Denver, or Cheyenne into Los Angeles. United's passengers now must transfer to Western's planes for L. A. Previous applications have been denied. . . . CAB examiners recommended that AA's application for approval of merger with Mid-Continent be denied, saying an "excessive" price had been offered by AA. . . . U. S. Circuit Court of Appeals, Washington, upheld CAB's award of Denver-Los Angeles route to Western in 1945; United had appealed from CAB's decision.

★ CROSS COUNTRY ★

If U.S. domestic airlines receive all new transports now on order, they will provide in 1948 a seat-miles capacity far surpassing the passenger-miles credited to Pullman travel in '41, according to a comparison developed by Alvin P. Adams & Assoc., aviation consultant company of Los Angeles. New equipment orders would give airlines a total of 1,125 planes, if DC-3s now operated are counted in; however, many of latter will be retired. Adams' study analyzes 1950 business as 165% over that of '45.

EAL moved airline's Tampa, Fla., operations facilities and all flight activities from Peter O. Knight Field to Drew Field in that city . . . Company is issuing newly devised seasonal booklets advising patrons on temperatures expected at destinations and giving tips on types of clothing to bring.

Santa Fe Skyway, recently organized subsidiary of Atchison, Topeka & Santa Fe Railway Co., purchased seven surplus Douglas C-47s and spares to supplement railroad's freight service with air cargo transport.

PCA took delivery on Douglas C-54 plane which carried late Pres. Roosevelt and his staff to historic Big Four conference at Casablanca. Now re-named "Capitaliner Milwaukee", craft carries a bronze plaque in cabin commemorating the conference flight.

New airlines: Monarch Airlines, Stapleton Airfield, Denver 7, Colo., operating in Rocky Mountain region, has been certificated by CAB. Head is Ray Wilson. . . . NATS Air Transportation Service is new non-scheduled airline operating from Oakland, Calif., Municipal Airport. Company, formed by ex-Naval Air Transport Service (NATS) pilots, received official permission to adopt name.

Grant of 3-yr. temporary certificates to feederline operators in Rocky Mountain and Fla. areas, followed by an examiner's favorable report on a feeder network in Tex. and Okla., is regarded by competent observers as start of nationwide short-line expansion. CAB and Post Office Dept. are increasingly favoring feeder expansion, in response to public opinion. CAB seems to have no fixed policy in choosing new companies against extension of existing operations. P.O. Dept. has set up a nine-man research board to prepare data in support of applications for routes which P.O. thinks will improve mail service.

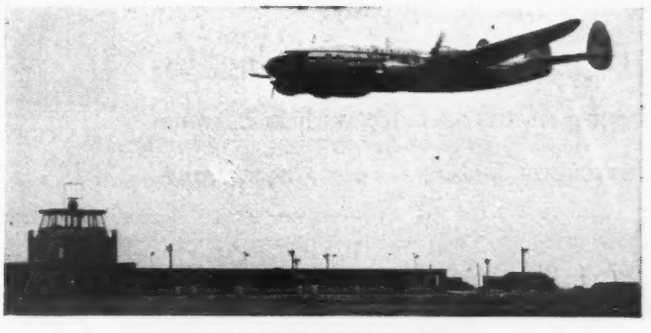
★ CANADIAN NOTES ★

By James Montagnes

New international scheduled air routes have been allocated by Canadian Air Transport Board. Colonial Airlines has been licensed to operate Montreal to N. Y. and Washington, and Ottawa to N. Y. and Washington (but not between Ottawa and Montreal). . . . TCA has received its license covering Toronto-N. Y. service, now in operation. Toronto-Chicago service is to start in July, and Toronto-Cleveland runs are to begin in August. Douglas DC-3 aircraft are to be used on all routes

Canadian mining companies frequently operate their own planes. Latest additions are Sherritt Gordon Airtransport, for Sherritt Gordon Mines in northern Manitoba; and Uscan Engineering Corp., for group of Yellow-knife (Northwest Territories) mining companies. Used are DC-3, DH Fox Moth, and two Noorduyn Norseman craft.

TCA Notes. Airline's first Canadian-built Douglas DC-6 is expected to be ready by year-end. Meantime, 24 converted C-47 transports are slated for use by late summer. . . . Chain of radar stations is being installed on Montreal-Windsor (Detroit) route, to aid pilots in telling distance from one or more selected ground stations. . . . TCA surplus of $32,772 for 1945 quadruples 1944 surplus of $7,409. . . . Decentralized traffic offices have been established by airline at Montreal, Toronto, and Vancouver.



IDLEWILD'S TEMPORARY HQ

Beyond PAA Lockheed Constellation, roaring across massive Idlewild Airport on recent inspection flight of terminal, is seen control-tower topped administration building which is to be employed until more permanent structures can be erected. Plane did not land.

"Operation 13"

C. & S.' new, four-motored Douglas "Skymaster," one of a fleet placed in regular operation recently.

FOR CHICAGO AND SOUTHERN

13 is a number of note for Chicago and Southern Air Lines, major Gulf-to-Great Lakes commercial air line. This year marks the 13th and — to date — most impressive milestone for this progressive and popular air transportation company.

Now, in this 13th year, C. & S. has begun regular service with fast super-luxurious DC-4s . . . and these huge, 4-motored space eaters rely—as has all C. & S. equipment for the last 10 years —on Sinclair Aircraft Engine Oil for safe, economical lubrication.

HARVEY L. WILLIAMS
Executive Vice President
C. & S. Air Lines

That's why we believe we can say with Harvey L. Williams, Executive Vice President, C. & S. Air Lines, that "aircraft lubrication by Sinclair adds up . . . to years of sure, efficient, highest-standard fleet operation."

SINCLAIR AVIATION OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

Since James H. Doolittle set a world's speed record of 296 mph at the National Air Races in 1932 using Hollow Steel Blades, this blade design has amassed a total of 77,000,000 flight hours. Only Curtiss can point to such a record, stemming from a production of more than 230,000 Hollow Steel Blades.

Blade research and development by Curtiss has brought to the aircraft industry new concepts of propeller weight, blade durability, and service life. Today steel has supplanted aluminum alloy and is the accepted standard for all higher horsepower applications.

Production of the first successful hollow steel blade is but one of the achievements of Curtiss propeller pioneering... *automatic synchronization* for greater passenger comfort, *reversible propellers* for shorter, smoother landings, *unit construction* for ease of maintenance, *simplified selector control* and *full feathering* propellers are all "firsts" by Curtiss.

Consider These Outstanding Curtiss Blade Features:

- Abrasion resistance characteristics especially suitable for reverse thrust operations.
- Simple monocoque construction provides most effective distribution of metal.
- Easy inspection throughout with conventional equipment.
- Available now in designs 10 to 19 feet in diameter.

CURTISS

ELECTRIC PROPELLERS

DIVISION OF
CURTISS WRIGHT
FIRST IN FLIGHT

'DOC' ATOR, FAMOUS AMERICAN AIRLINES CAPTAIN, CHOOSES AIRADIO FOR HIS PERSONAL PLANE

'DOC' ATOR is an old hand at piloting the great Flagships of American Airlines. In fact, 'Doc' loves flying so much that when he's through with his regular runs, he steps into his personal plane and takes off for a fishing trip.

"Being an airline pilot," 'Doc' Ator told us the other day, "I know that every plane should have a two-way radio. Personally, I have an Airadio Super '52' in my own plane.

"I was looking at an Airadio ad that had the phrase, 'more power per radio ounce.' Brother, they aren't kidding! It always sort of surprises me when I hear how much volume can come out of such a small set. The Super '52' is a swell outfit."

Thank you, Captain Ator. And remember... besides all the features 'Doc' Ator has talked about, Airadio also gives you easy-installation, standard-size components replaceable anywhere, long-range reception and transmission, *plus* the assurance of uncompromising quality built-in by Airadio's pilot-engineers.

'DOC' ATOR SAYS:

"Airadio is the only set I've seen that makes me feel as safe in my small ship as I do in a Flagship. Also, it's a lot more fun when you have company on a flight and can tune in your favorite radio program."

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★ INTERNATIONAL BRIEFS ★

ENGLAND—Heath Row, now bearing new name, London Airport, will soon be a base of operations for both Pan American and American Overseas. Trip into town will be cut to 30 min. Time from Hurn has been 3 hr.

Fairey is developing a new type helicopter, named **Gyrodyne,** combining features of both copter and autogiro. Gyrodyne is intended to provide new simplicity and safety.

Ministry of Civil Aviation is preparing a complete chain of direction finder stations in England to aid development of safe flying. Britain has been divided into six regional districts to simplify organizational setup.

British European Airways expanded its services with connections to Copenhagen, Oslo, and Athens via Marseilles, and Rome.

BSAA is reported to have undercut PAA's mail rate for carriage from Argentina to England. It's said line is obtaining virtually all European airmail from Argentina.

A four-cylinder opposed air cooled engine of 75 to 100 hp., depending upon bore, was introduced by Monaco Motor & Engineering Co. Cubic displacement is 182 cu. in. for 75 hp. model and 218 cu. in. for 100 hp. engine. Weighing around 200 lb., engines were developed to compete with low-power American types.

BELGIUM—Recently reported interim air agreement (Mar. AVIATION) was superseded by a final accord, providing use of Leopoldville in Congo by U. S. airliners, also landing rights at Brussels.

RUSSIA — Commercial airlines are planning a network of more than 100,000 mi. by 1950, for which 20 new airports and 16 intermediate fields will be built. All equipment and facilities are to be expanded and modernized.

HOLLAND—KLM was awarded landing rights at Miami and N. Y. C. Trans-Atlantic service opened May 21. Miami route has been in operation throughout war under emergency permits.

FRANCE—Numerous types of postwar aircraft were shown at air show near Paris recently. Most were prototypes, though some have been produced for export. Presented were a small single-seater costing about $1,000, and a two-seater flying wing.

NORWAY—Latest entry in trans-Atlantic race is DNL, official airline managed by Col. Bernt Balchen, who recently took delivery of company's first Douglas DC-4. DNL eventually is expected to join Sweden and Denmark for a combined Scandinavian service to N. Y.

EGYPT—Formation of a new Egyptian airline with BOAC holding 50% interest is considered another step in British plans for covering Europe with a network of British-controlled local companies. Such organizations have been formed in Eire, Greece, and Egypt.

New French magazine, "Decollage," presents details on three-place Nord 1200, awarded Governments Grand Prize for touring planes. Tricycle geared, craft cruises at 135 mph., consumes 1 gal. every 18 mi., and weighs 1,215 lb. empty.

Latest four-engined French plane is Languedoc 161, built at Toulouse. With 100 ft. span, gross weight of 51,000 lb., and four 1,260 hp. Gnome & Rhone engines, plane cruises at 230 mph., and it is stated it can carry 33 passengers 1,000 mi., or 7 tons of cargo 500 mi.

SPAIN—Iberia, Spanish airline, now operates seven Douglas DC-3's and three DC-2's on services between Spanish possessions and to Lisbon. Plans call for services to Buenos Aires, Geneva, London, and Paris, to be operated with DC-4's.

EIRE—New airline was formed to connect Ireland with Britain and Continent, with BOAC holding a 40% interest. A new Anglo-Irish air agreement provides for specification of service frequencies, and new company is expected to aid in control of Irish international airlines.

INDIA—Indian National Airways ordered six Vickers Viking 24-passenger airliners, with which it plans to operate its proposed routes.

AUSTRALIA—Airline bill battle is continuing with ANA's request for permission to appeal to Privy Council against High Court decision, which held that bill was valid insofar as it permitted Government operation of its own air services.

British technical missions will make rocket bomb tests in Australian South Eastern Desert. Headquarters have been set up at Ceduna.

Mascot airport at Sydney is being expanded at a cost of $20,000,000 to include an 8,000-ft. runway and three smaller 5,000-6,500 ft. runways. It is felt this expansion will be sufficient till 1955, when further construction is planned.

Australian Government has completed negotiations for purchase of BOAC's interest in Qantas making it a purely Australian, and also a government-controlled, concern.

CHILE—Coincident with Air France's reopening of Paris-Santiago service, agreements were completed with Argentina and Brazil allowing reciprocal air services to and from Rio and Buenos Aires.

MEXICO—Panini's sale of 49% of its stock to New Haven interests fell through when Panini upped his price. A later attempted sale to CMA was not completed for similar reasons. Company is still looking for a buyer.

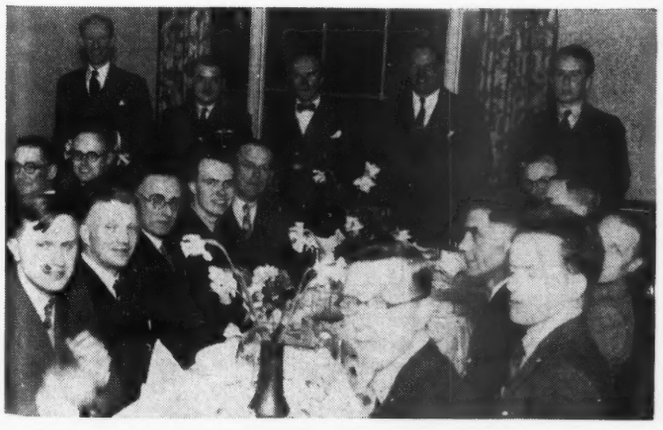
WORLDATA . . . . . By "VISTA"

With controversy in Washington and London over the TWA-Italy airline arrangement, there already are some indications that similar arguments will plague the TWA-Ethiopia contract. The Italian contract, signed last February, provides for 40% TWA participation in a new Italian airline, to operate domestic and international services. Talk of "secret" angles in the Bermuda decisions is discounted; it appears, rather, that the British feel their particular spheres are being invaded.

There are further considerations, on the British side, involving realization that American management of foreign airlines means American equipment, and that such contracts would eliminate for many years foreign air transport markets which Britain needs. In any case, fruition of the Bermuda plans apparently will have to wait till the Italian crisis passes, and may even be postponed until the Ethiopian plans of TWA are fully aired.

Parliament in London finally received the long-awaited airline nationalization bill. Organization of three national airline companies has already been reported. Bill, providing for government purchase of all British airports, calls for subsidies of $50 million each of the first two years, and $40 million per year for eight years until 1956. Capitalization maximums were set at $200 million for BOAC, $80 million for British European Airways, and $40,000,000 for British South American Airways. . . . While charter companies supposedly are to be encouraged, wording of the present measure is such that virtually any chartered airplane flying between two airports served by one of the three government corporations becomes subject to scrutiny. . . . Airports can be acquired by purchase, but outright confiscation of land is also mentioned in legislation. Latter feature, together with provision that when existing airlines are taken over they will be reimbursed for actual property values only, is expected to cause considerable debate.

Recent British Commonwealth Air Conference in New Zealand dealt with formation of British Commonwealth Pacific Airlines to operate a route to America and Canada parallel to a Canadian company. Until this new line can get started, services would be operated temporarily by an existing airline, but so far no decision has been announced. ANA with its new Douglas DC-4s, is ready to run twice-weekly services, but cannot operate without official sanction. In meantime, Australia is without direct connections across the Pacific, causing serious concern in Australian business circles. Main hold-up now appears to be submission to Washington of a reciprocal U. S.-Australian air agreement, without which neither PAA nor any Australian company can operate.



WHITTLE HONORED BY COLLEAGUES

Following resignation of Air Commodore Frank Whittle (second from left, standing) from board of Power Jets, Ltd., a farewell dinner was tendered him by original members of company's engineering staff. Upon decision of British government to convert firm into National Gas Turbine Establishment, Whittle left concern and most of technical engineers are following his lead. Depicted in back row (left to right) are: J. C. B. Tinling, Power Jets founder; Whittle; W. E. P. Johnson, Power Jets executive; Michael Daunt, Gloster test pilot; and R. D. Williams another Power Jets founder.

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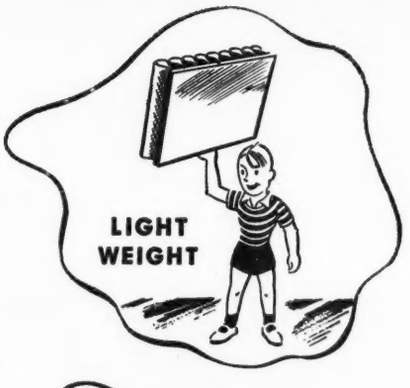

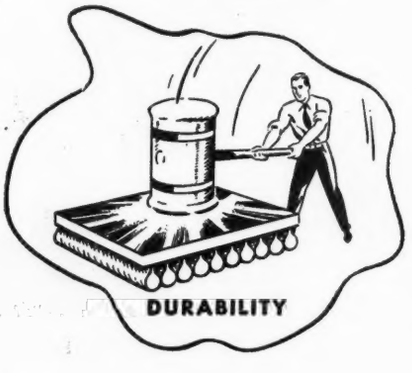

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NUKRAFT MANUFACTURING CO., INC.

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Curtiss-Wright has a backlog of $86,000,000 in unfilled orders but sustained a loss in first quarter operations, according to Pres. Vaughan. Company is consolidating its 17 wartime plants into 3, where peacetime manufacture of engines, propellers, and airframes will proceed.

Control of United Aircraft Products, Inc., was won by officials of Metal Products Corp. at recent annual meeting. Following election, it was voted to split common stock on 2-for-1 basis. Five new directors were elected, the old management retaining four directors.

Lockheed plans "an aggressive entrance into private plane field as soon as certain basic problems have been solved," Pres. Gross reports. Unfilled orders are $199,739,000, of which $144,000,000 are military and $55,000,000 civil (transports).

Republic reports first quarter net income of $546,608 or 55c. a share on sales of $13,609,-068. Pres. Alfred Marchev stated that unfilled orders were $66,950,000 on Mar. 1, against $45,276,000 at end of '45. In addition. Aircooled Motors, a subsidiary, had orders of $5,028,000, of which $1,030,-000 represented orders other than Republic's.

U. S. Air Lines, Inc., of St. Petersburg, Fla., has registered with SEC 900,000 shares of common stock, which will be offered to public at $3.25 a share. Proceeds will be used to pay up a bank loan and finance additional company equipment.

Beech reports net loss of $154,-847 for six months ended Mar. 31. Sales were $9,946,000 for period. Since January, company has shown a profit on operations.

Bendix Aviation Corp. reports net loss of $1,415,720 for three months ended Dec. 31, 1945. Deficit before a tax carryback refund of $3,430,000 was $4,-845,720.

Dividends: Bellanca directors have decided to forgo declaration of a common dividend at this time. Last December a 12½c. dividend was declared, and directors stated their intention to pay dividends quarterly. . . . Continental Motors paid a 15c. dividend last month, first declared this year. Four 20c. dividends were declared in 1945. . . . Aeronca paid a 13¾c. dividend last month, while Consolidated Vultee paid 50c. a share and United Air Lines announced a 50c. dividend to be paid on July 1.

Northrop anticipates "satisfactory earnings" after current fiscal year, which ends July 31, according to Pres. Northrop. Unfilled orders are $53,-500,000. Company's Salisbury Motors Div. is expected to develop sales of about $10,000,-000 annually.

Bendix Helicopter, Inc., reports organizational and registration expenses of $118,981 in '45. Current assets were $1,-269,348 at end of 1945, of which $1,169,273 consisted of cash. Current liabilities were put at $19,705.

Solar reports '45 net income of $298,919 or 93c. a share, against '44 net income of $443,662 or $1.43 a share.

Colonial Air Lines stockholders have approved an increase from 500,000 to 1,000,000 shares in authorized capital stock, but company has no present intention to augment its 365,600 outstanding shares by a further issue.

Commonwealth Aircraft has private plane backlog of unfilled orders totalling $40,000,-000, according to Pres. Voyes.

United Aircraft has enough orders on hand to keep its 20,000 workers busy until middle of '47, according to Chairman Rentschler. Company has settled its account of $723,000,000 in terminated government military orders for $52,000,000.

United Air Lines profits in 1946 will be "substantially" lower than last year, Pres. Patterson reports. Company plans some financing in form of bank loans in near future. Passenger revenues are expected to increase about 55% this year, while mail revenues may be down by 30 to 50%.

Douglas will "probably break even" on 1946 operations, Pres. Douglas told stockholders at annual meeting. He said that airlines were rapidly becoming "over-seated." Although company has considered possibility of making personal planes, Mr. Douglas said nothing tangible has been done along this line to date.

Kollsman Div. of Square D Co. has weathered changeover from strictly war production to peacetime output, and its prospects are bright, according to Pres. Magin. Kollsman's current sales, he recently told stockholders, "is greater than we had expected."

Piper has registered 150,000 shares of 4½% stock for sale to public. Proceeds will be used to retire a $63,000 mortgage and to pay bank loans of $400,000. Increase in working capital is desirable, according to company officials, due to need for carrying increased inventories.

★ OBITUARY ★

Alex Papana, well-known test pilot and stunt flyer. He once served as personal pilot to King Carol of Rumania, and after arrival in U. S. in 1932, he flew at the National Air Races, distinguishing himself in precision aerobatics. As test pilot, he was successively associated with various aircraft makers, and he recently organized his own test-service group.

Storm W. Archer, consulting engineer for Ampco Metal and formerly professor of aeronautics at Tampa U. An Army pilot in World War I, he later participated (1927) in a world flight from N. Y. to Bombay and return.

ADDING IT UP.....By RAYMOND HOADLEY

Airline Financing. More than 600 airliners costing from $200,000 to $1,500,000 each have been ordered by American airlines—and now the time is fast approaching for payment on some of these contracts. Deliveries are already under way on some orders, will soon start on others. One line is reported seeking a rather large loan from RFC, while another expects to negotiate some private bank loans to take care of its $52,000,000 expansion requirements over the next 12 to 18 months. Late 1947 is expected to see some 1,095 airliners in operation, as against a current total of 522 craft owned.

Export-Import Bank. Several airlines are reliably reported to have approached the Export-Import Bank for equipment loans, only to receive complete turn-downs to date. The bank's attitude, as one of its officials explained it to us, is that the airlines have sufficient credit standing to do their necessary financing in the usual channels instead of going to the government for assistance. Export-Import Bank did make a loan to TACA lines some time ago, but officials maintain that this was a special situation and should not be considered a precedent for large-scale financing of domestic lines by the bank.

Reports to Stockholders. N. Y. Stock Exchange has been a bit irked at aircraft companies listed on the Big Board —for being too miserly with their interim reports to stockholders. Taking the tip, it's expected that the listed aircraft concerns will hereafter issue quarterly reports, including sales data, earnings, and backlogs.

Back to Normalcy. Now that some of the bookkeeping burdens involved in war production are lessening, this stand on the part of Exchange officials seems reasonable. While renegotiation, termination, etc., have given abundant reason for aircraft concerns to be anywhere from six to ten months late in submitting their past reports, these companies should now be able to get out their annual statements as early as do the other 1,200-odd industrial companies listed on the exchange.

Contract Settlement. Most of the terminated war contracts still awaiting settlement are concentrated in the hands of a few major contractors. Estimated amount of fixed-price claims remaining to be settled is about $3 billion. Based on experience of recent months, these claims will be settled for $2.7 billion. Some $405 million in cost-plus-fixed-fee contracts remain to be paid. Of the underlying subcontracts, 88% have been settled. Moreover, 81% of the plant-clearance job was completed by Mar. 31.

Personal Planes. Protests are heard daily from private plane manufacturers that they're unable to get steel, aluminum, long staple cotton, and other essential materials. Already, forecasts of 1946 lightplane output have been whittled down to 20,000, and now the latter estimate begins to appear to be on the overly optimistic side. Suppliers argue they're often held up by price uncertainties.

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In the major industries, wherever wheels turn, Bower Roller Bearings carry the rolling loads. Invisible but indispensable, they perform silently and faithfully the most important tasks in the mechanical world. There is nothing in industry that is finer in design, more accurate or more nearly perfect in performance than Bower Roller Bearings. Bower precision is measured in millionths of an inch.

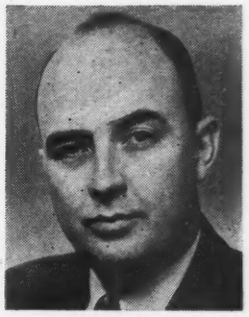
B O W E R - R O L L E R B E A R I N G S

FLOYD W. CARLSON, chief helicopter test pilot for Bell Aircraft, has been declared outstanding young man of year by Buffalo Junior Chamber of Commerce, and in recognition thereof, he is recipient of Gold Key, emblematic of honor bestowed upon him.

GRANT W. C. McCONACHIE, gen. mgr. of CPA at Edmonton, has been awarded McKee Trophy for '45 for his outstanding contribution to commercial flying in Canada. A pioneer operator of northern air routes, he was educated at University of Alberta.

FRED W. HERMAN, has been appointed plant mgr. for Douglas at company's Long Beach plant, where he was formerly chief engineer. He has been associated with company for 15 yr. Previously he was with engineering div. of AAF at Dayton, Ohio.

JACOB E. SMART has been named executive vice-pres. of Air Power League. A West Point graduate, he was formerly a colonel in AAF, and has served as adviser to Gen. Arnold. He holds a DSC, DFC, and Air Medal with three oak leaf clusters.



COL. FRED M. GLASS has been appointed vice-pres. of PCA in charge of its southern region, with hq. at Washington, D. C. During war, he was chief of staff for Pacific Div., ATC, and before war he acted as airline CAA counsel. His AAF rank was Col.

MARVIN A. HEIDT has been named vice-pres. in charge of industrial relations for Bendix Aviation. He joined company in '39 as dir. of industrial relations. Previously he served in same capacity for Dodge Brothers and Edward G. Budd Mfg. Co.

LT. COL. L. A. HARDESTY has been appointed director of operations for TACA with hq. in Miami. He was formerly commanding officer of an ATC group operating over "Hump", and had been with AAF since '40. A graduate of U. of Wash., he learned to fly in '30.

CAPT. OLIVER J. STUREMAN has been named operations mgr. of PAA's Latin American Div., with hq. in Miami. During war he supervised international airline's contract operations for NATS. A veteran pilot of more than 10 yrs., he has flown in all parts of globe.

RICHARD W. DARROW has been appointed director of public relations for Glenn L. Martin. Previously he had been mgr. of public and internal relations at C-W, Columbus div. He is a graduate of Ohio Wesleyan University and a member of NAA and APL.

HAROLD M. PARSEKIAN has been appointed director of sales and technical service for Glenn L. Martin's Plastics & Chemicals Div., where he will be in charge of sale of company's new Marvinol polyvinol resins. He was formerly associated with Binney & Smith Co.

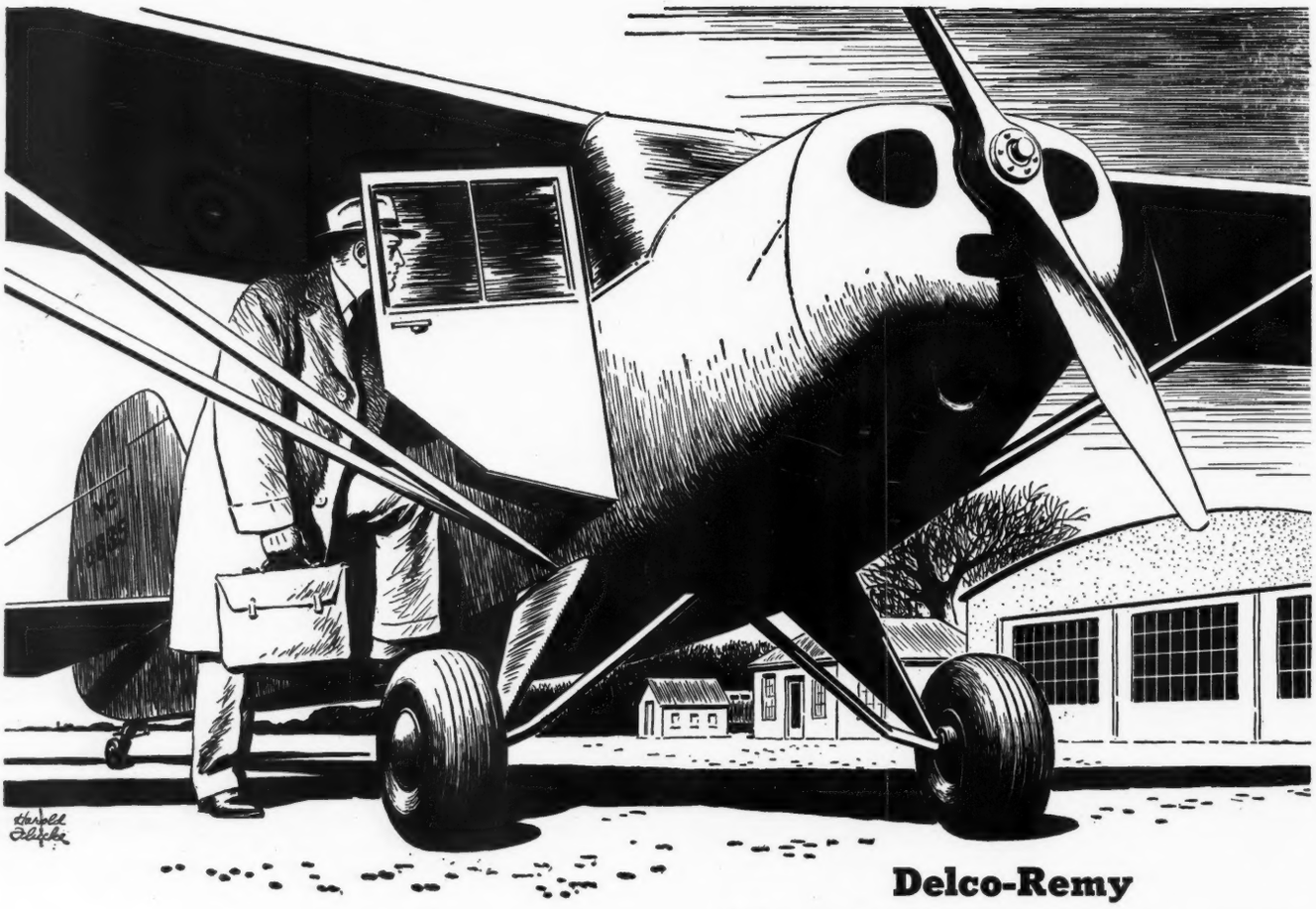
CHARLES W. PERELLE has been elected pres. of Gar Wood Industries. Formerly v.-p. in charge of manufacturing for Convair, he was responsible for company's top record in AAF production ratings. He also installed first mechanized assembly line in aircraft industry.

GEORGE F. CHAPLINE has joined Fairchild's Ranger Aircraft Engines Div. as asst. gen. mgr. He served as a capt. in Navy during War and commanded an air base unit in Marshall Islands. A pilot for over 25 yr., he is an associate fellow of IAS. (Tommy Weber photo)

CLIFFORD E. ROBERTS has been appointed Washington, D. C. representative, engineering and sales, for Boeing Aircraft. Previously asst. chief engineer for Glenn L. Martin, he served in Naval Reserve as an aviation specialist since '33, and he's owned and flown his own plane.

STEWART FAULKNER has joined CAL as director of advertising and publicity. Formerly, he was national promotion mgr. of PCA. During war he was asst. general traffic mgr. and advertising dir. for Lockheed and Alaska Airlines. His hq. will be at Continental's Denver offices.

BRIG. GEN. LAWRENCE J. CARR was elected pres. of Institute of Air Transportation. A graduate of West Point, he was attached to 7th Air Force during war as chief of staff to commander in charge of all land-based aviation. Previously, he was with Trans-Caribbean. (Volpe photo)



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ENGINEERING

Fluid Measurement 1

Containing engineering data on fluid measurement, also related factors of equipment, and computations in terms of steam, water, oil, and gas flow, new handbook has been issued by **Brown Instrument Co.**, Philadelphia.—AVIATION, June, '46.

Hand Miller 2

New 16 mm. color sound movie, "The Miller That Uses Its Head," announced by **Nicholas-Morris Corp.**, New York City, shows various types of tooling and fixture design, from stock fixtures to completely automatic fixtures.—AVIATION, June, '46.

Copper Alloy Welding.....3

"Welding and Brazing of Copper and Copper Alloys" is new handbook published by **C. E. Phillips & Co.**, Detroit, giving definitions of processes and materials, data on compositions and properties of commonly welded and brazed copper alloys, and information on welding and brazing.—AVIATION, June, '46.

Radio in Aviation.....4

Various items relative to radio in the aeronautical field are included in Vol. 2, No. 4 of "Bendix Radio Engineer" published by **Bendix Aviation Corp.**, Baltimore. —AVIATION, June, '46.

Indicating Instruments 5

Publication, "Weston Engineering Notes," issued to provide application engineering information to users of electrical indicating instruments, is offered by **Weston Electrical Instrument Corp.**, Newark, N. J.—AVIATION, June, '46.

Welding Data 6

Giving engineering data and feature article on welding high tensile steel with chrome-moly electrodes, "Welding Briefs" published by **Metal and Thermit Corp.**, New York City, includes other information on various welding problems.—AVIATION, June, '46.

Replacing Stripped Threads.....7

Containing instructions for installing "Heli-Coils" in tapped thread repair work, Bulletin No. 300 from **Aircraft Screw Products Co.**, Long Island City, N. Y., also gives specifications and part numbers of accessory tools recommended for use with inserts used in repair of stripped threads.—AVIATION, June, '46.

Cleaning and Drawing Compounds.....8

New 24-page catalog from **Northwest Chemical Co.**, Detroit, contains information on five types of cleaning compounds and also on five types of drawing compounds.—AVIATION, June, '46.

Slide Rule 9

Folder from **Charles Bruning Co.**, Chicago, describes new slide rules made from plastic material stated to give greater dimensional stability.—AVIATION, June, '46.

Flow Meters 10

Bulletin F1603 released by **The Bristol Co.**, Waterbury, Conn., describes new bellows type differential flow meter, giving ranges available in both recorders and controllers.—AVIATION, June, '46.

Aircraft Tubing 11

Ohio Seamless Tube Co., Shelby, Ohio, has issued new list of aircraft tubing stock. Covered are round, streamlined, oval, elliptical, square, and rectangular tubing.—AVIATION, June, '46.

Lock Nut 12

Folder from **Grip Nut Co.**, Chicago, describes "Gripco" one-piece lock nut stated to be unaffected by oil, water, or chemicals. —AVIATION, June, '46.

Pumps and Stirrers.....13

Describing line of midget pumps and laboratory stirrers, new catalog from **Eastern Engineering Co.**, New Haven, Conn., also gives specification and performance data.—AVIATION, June, '46.

Tool Steels 14

New brochure describes steel tools, including dies, cutters, cams, and forming rolls, cast to shape by **Jessop Steel Co.**, Washington, Pa. Also given are technical and engineering data.—AVIATION, June, '46.

Friction Tape 15

Stated to give adequate insulation in single layers for lines up to 220v. and in double layers up to 650v. new friction tape is described in catalog section issued by **B. F. Goodrich Co.**, Akron, Ohio.—AVIATION, June, '46.

Feed Calculator 16

New slide-rule type devices for calculating proper feed per tooth for all types of carbide milling cutters is described in literature from **Wendt-Sonis Co.**, Hannibal, Mo.—AVIATION, June, '46.

Tap Extractors 17

Folder from **Walton Co.**, Hartford, Conn., describes line of tap extractors for standard hand taps, machine screw taps, and pipe taps.—AVIATION, June, '46.

Surface Inspection 18

"Faxfilm", described in literature from **Faxfilm Co.**, Cleveland, is designation for company's material and method enabling naked eye examination of details of various surfaces and which without photography, makes permanent record of surfaces studied.—AVIATION, June, '46.

Drill Chip Breaker.....19

Bulletin No. 28161 issued by **Continental Tool Works**, Detroit, describes drill chip breaker, giving installation and operating instructions as well as technical information on drilling practice.—AVIATION, June, '46.

MACHINERY & ACCESSORIES

Surface Quality Control.....20

Catalog from **Physicists Research Co.**, Ann Arbor, Mich., describes profilometer for measuring quality of metal surfaces, giving specifications and applications.—AVIATION, June, '46.

Infra-Red Units 21

Specifications and description of infrared lamp units are given in bulletin from **Miskella Infra-Red Co.**, Cleveland.—AVIATION, June, '46.

Live Centers 22

Sturdimatic Tool Co., Detroit, has released new catalog describing live centers made with standard Morse taper, covering

AVIATION READER'S SERVICE — JUNE 1946

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NAME.....TITLE.....

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ADDRESS.....

special purpose applications, and giving specifications.—AVIATION, June, '46.

Machine Tools 23

Catalog from **Zagar Tool Co.**, Cleveland, describes line of collet chucks, broaching machines, and multiple drill heads, giving specifications, technical data, and special features.—AVIATION, June, '46.

Guide Post Bushings.....24

Bulletin No. 80 from **Ampco Metal**, Milwaukee, describes line of aluminum bronze guide post bushings furnished in standard sizes and available from stock.—AVIATION, June, '46.

Carbide Tools 25

Specifications of carbide tools and masonry drills are given in bulletin from **Metro Tool & Gage Co.**, Chicago.—AVIATION, June, '46.

Surplus Machine Tools.....26

Booklet issued by **National Machine Tool Builders Assn.**, Cleveland, gives questions and answers on how to buy government-owned surplus machine tools. Included is list of surplus sales and information offices, formula for determining prices of standard tools, and regulations affecting sale of equipment.—AVIATION, June, '46.

Gages 27

Horberg Gage Co., Bridgeport, Conn., announces Bulletin B concerning sets of drill size pin gages, numbered, lettered, or fraction type.—AVIATION, June, '46.

Screw Machine Drills.....28

Designed for operations requiring short drills, line of stub screw machine drills is described in circular from **Chicago-Latrobe Twist Drill Works**, Chicago.—AVIATION, June, '46.

Industrial X-Ray 29

List of about 400 articles on industrial radiology (supplementing references in "Industrial Radiology" published in 1943 by John Wiley & Son), includes authors, titles, and locations. Compiled by H. R. Isenburger, list is available from **St. John X-Ray Service, Inc.**, Califon, N. J. Charge is $1.00—AVIATION, June, '46.

Hand Screw Machine.....30

Catalog from **Wade Tool Co.**, Waltham, Mass., describes new hand screw machines intended for modern, fast, economical production of second operation work.—AVIATION—June, '46.

Openside Planer 31

Containing facts about design, construction, and operation of openside planer, brochure No. 310, issued by **Rockford Machine Tool Co.**, Rockford, Ill., also gives specifications on four rated sizes, each available in five stroke lengths from 10 to 20 ft.—AVIATION, June, '46.

Carbide Tipped Face Mills.....32

Bulletin No. FM-46 from **Tungsten Carbide Tool Co.**, Detroit, describes new standard "Vibra-Cushioned" carbide tipped face mills. Featured are inserted and fixed blade type of cutters for steel milling.—AVIATION, June '46.

Collets and Feed Fingers.....33

Specifications and description of line of collets and feed fingers for automatic and hand screw machines, lathes, and milling machines, are given in new 28-page catalog from **Sutton Tool Co.**, Sturgis, Mich.—AVIATION, June, '46.

Pneumatic Positioners 34

Designed for operating remote indicators, recorders, and flow controllers; for adjusting flow controller settings from remote points; and for positioning automatic ratio control units, pneumatic positioner is described in Bulletin No. 55-A from **Fischer & Porter Co.**, Hatboro, Pa.—AVIATION, June, '46.

Flexible Shaft Grinder.....35

Literature from **Spring Specialty Co.**, Maywood, Ill., describes Model VB-2 flexible shaft grinder operating at 18,000 rpm. and accommodating ⅛, 1/16, and 1/32 in. arbors.—AVIATION, June, '46.

Lubricating Brush 36

Designed to lubricate and clean taps, drills, and reams mounted on drill presses, and also punches, "Lubro-Brush" is described in catalog issued by **Charles L. Jarvis Co.**, Middletown, Conn.—AVIATION, June, '46.

ELECTRICAL

Relays 37

Bulletin 130 issued by **Ward Leonard Electric Co.**, Mount Vernon, N. Y., describes line of relays available.—AVIATION, June, '46.

Electronics 38

Articles on specific electronic applications and explanation of electronic theory, and basic electronic devices are featured in new booklet, "Electronics Digest," issued by **Westinghouse Electric Corp.**, Pittsburgh.—AVIATION, June, '46.

Battery Chargers 39

Specifications and description of motor-generator multiple-circuit type battery charger for hand-lift trucks, are contained in Bulletin No. 205 from **Electric Products Co.**, Cleveland.—AVIATION, June, '46.

Radio Interference Filters.....40

Catalog from **Sprague Products Co.**, North Adams, Mass., gives information on construction, installation, and performance of "Filterol" radio interference filters.—AVIATION, June, '46.

Switches 41

Handbook No. 200, from **General Control Co.**, Boston, Mass., describes line of lever switches for radio, signal equipment, and electronic devices.—AVIATION, June, '46.

Resistors 42

Containing information on line of "Riteohm" ½ and 1w. non-inductive pie-wound resistors, Bulletin No. 126, issued by **Ohmite Mfg. Co.**, Chicago, gives electrical, mechanical, and dimensional data.—AVIATION, June, '46.

NEXT-DOOR service on steel

Quick delivery to your plant

ELEVEN Ryerson Steel-Service Plants provide unmatched facilities virtually next door to every steel user in the principal markets of the United States. Though many sizes are missing because of the steel shortage, each Ryerson plant has large, diversified stocks. Each is backed up by the inventories and facilities of the others. These strategically-located steel stocks plus modern high speed equipment are your assurance that orders will be filled accurately and promptly.

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Principal Products: **Carbon and Alloy Steels, Allegheny Stainless, Tool Steel, Bars, Plates, Sheets, Structurals, Mechanical Tubing, Inland 4-Way Floor Plate, Reinforcing Bars and Accessories, Boiler Tubes, Welding Rod, Babbitt, Bolts, Rivets, Metal Working Tools & Machinery, etc.**

RYERSON STEEL

STEELS

Stainless Steel 43

Allegheny Ludlum Steel Corp., Brackenridge, Pa., has issued handbook on various types of stainless steels, including finder table, corrosion resistance, discussions of properties, and fabrication methods.—AVIATION, June, '46.

Corrosion of Steels.....44

Containing information on how various types of commercial steels may be expected to resist attack of atmospheric corrosion, booklet, "Corrosion of Steels", has been issued by Carnegie-Illinois Steel Corp., Pittsburgh.—AVIATION, June, '46.

PLASTICS

Protective Coverings 45

Literature from Celanese Plastics Corp., New York City, contains descriptions, technical data, and types of applications of "Lumarith" plastic sheets and foils.—AVIATION, June, '46.

PLANT SERVICE

Fire Extinguisher 46

Folder issued by Randolph Laboratories, Inc., Chicago, describes new 15-lb. CO_2 fire extinguisher featuring trigger-touch release.—AVIATION, June, '46.

Foam Type Extinguisher.....47

Brochure from Pyrene Mfg. Co., Newark, N. J., describes air foam as fire fighting material, and includes information on what it is, how it works, and applications.—AVIATION, June, '46.

AIRCRAFT & ACCESSORIES

Tachometers 48

Line of tachometers, including centrifugal, chronomatic, vibrating reed, and portable and stationary types, is described in Bulletin No. 1045 from Herman H. Sticht Co., New York City.—AVIATION, June, '46.

Photographic Equipment 49

Booklet from Abrams Instrument Corp., Lansing, Mich., covers line of photographic equipment for aerial map work, including vertical and oblique cameras, contour finders, control timers, mechanical triangulators, combat cameras, and printing boxes.—AVIATION, June, '46.

AIRPORTS

Generators 50

Bulletin L-406 from Homelite Corp., Port Chester, N. Y., describes portable gasoline driven generators ranging in size from 500 to 5,000w., ac. or dc., 6 to 230v., and 50 to 800 cycle.—AVIATION, June, '46.

Hangars 51

Featuring innovations in hangar design, bulletin from Star Manufacturing Co., Oklahoma City, describes construction of company units.—AVIATION, June, '46.

Facsimile Machine 52

Designed for transmission and reception of messages at high speed, including written material, pictures, and weather maps, two new facsimile machines—one for handling 30,000 words per hour or 2,760 sq. in. of picture copy, other unit for slower speed for automatic framing and ejection of messages—are described in literature from Finch Telecommunications, Passaic, N. J.—AVIATION, June, '46.

Excavator 53

Folder from Trackson Co., Milwaukee, describes Model IT4, earth moving shovel to be operated with crawler tractor in excavating, grading, loading, and material handling jobs.—AVIATION, June, '46.

Cable Runway 54

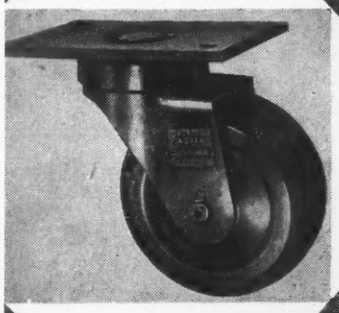
Designed to enable planes to land and takeoff without coming in contact with ground is special cable runway described in folder from Brodie Engineering Corp., Baltimore. Apparatus consists of cables stretched taut between masts, with hook-on device provided for aircraft. Cable runway is intended for employment in locations where use of a conventional landing strip is unfeasible.—AVIATION, June, '46.

Demand DARNELL

CASTERS

& E-Z ROLL

WHEELS



It's easy to select the right caster to meet your exact requirements from the Darnell line. There are nearly 4000 models from which to choose. All Darnell Casters and Wheels are pre-tested

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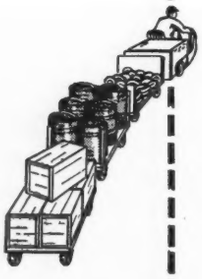
Bond 140-AH Heavy Duty Series. Rugged steel construction for heavy duty service with safety. Double ball race design. All races hardened. Swivels with frictionless ease. Pressure lubricated throughout. Available in three wheel diameters: 8", 10" and 12". Load capacities up to 4,500 pounds per caster.

Assure efficient trailer truck service with a caster that's *right* for your loads and *right* for conditions in your plant. Bond REG U.S. PAT OFF. 140-AH is a built-for-the-job structural steel caster that's easy-swiveling and practically indestructible. It's built to take a beating... built to take the turns... do the job *right*. Get the caster that's exactly right. Get Bond REG U.S. PAT OFF. Send for catalog now—it's free!



BOND FOUNDRY & MACHINE CO.
MANHEIM, PA.

MANAGEMENT & EMPLOYEES

Training Films 55

Catalog published by **Castle Films**, New York City, describes collection of educational and training films now available to industry.—AVIATION, June, '46.

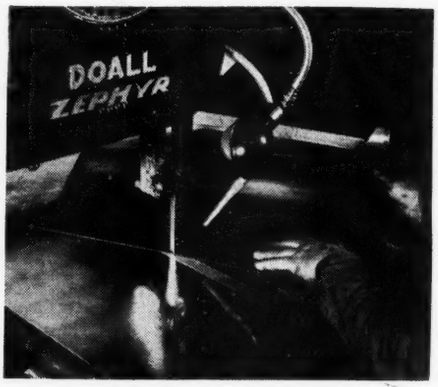
MERCHANDISING

Sales Aid 56

Literature from **Polaroid Corp.**, Cambridge, Mass., describes two new products developed as sales aids: Selectographs, designed to present "before and after" effects; and Vectographs, designed to show three dimensional pictures.—AVIATION, June, '46.

NEW·PRODUCTS

Machinery & Accessories

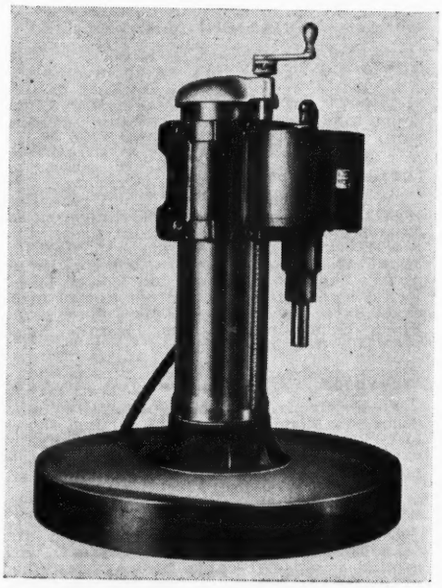


Metal-Cutting Band Saw.....57

For cutting sheet steel, aluminum, ferrous and non-ferrous castings, as well as paper, wood, plastics, laminates, and composition materials, new band saw, "Zephyr 16", is announced by **DoAll Co.**, Minneapolis.—AVIATION, June, '46.

Pneumatic Column Press.....58

Particularly useful for small to medium runs where it is desirable to leave fixtures mounted to base, new air operated column press is announced by **Mead Specialties Co.**,

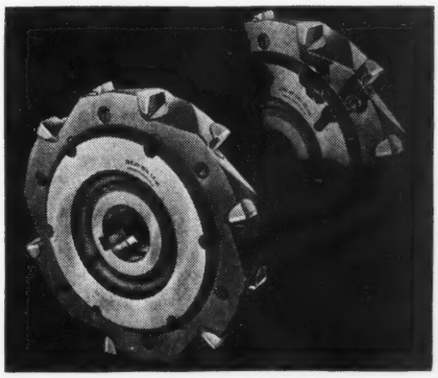


Chicago. Unit can deliver ram force of 3,000 lb. on 110-lb. line pressure. With column press, successive operations may be performed by swinging ram over desired fixture, raising or lowering to right height

with raising screw, and locking in place with drawbolts. In some cases a dozen or more small jobs may be left set up. Height over all, excluding handle, is 24¾ in., dia. of table is 23½ in., stroke 3 in., clearance of ram above table 11 in., depth of throat 4¾ in., and weight 285 lb. Power factor is 28 times line pressure.—**AVIATION, June, '46.**

Slotting Cutter 59

Control of blade settings, obtained by screw adjustment to blade locking device, is feature of Type F slotting cutter made by **Lovejoy Tool Co.**, Springfield, Vt. To adjust blade, either for resharpening or for

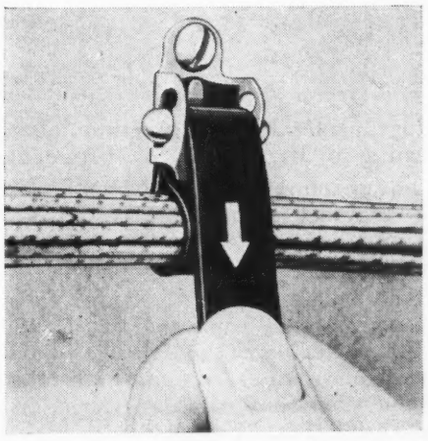


controlling slot width, locking device is loosened by unseating taper pin. A recessed-head screw, at bottom of each blade, is turned to move blade. Blade is locked in body by reseating taper pin. Positive and negative rake cutters are available in face widths from 7/16 to 1½ in., and diameters from 5 to 18 in. Cutters are equipped with tungsten carbide tipped, high speed steel, or cast alloy blades.—**AVIATION, June, '46.**

Shop Equipment & Materials

Harness Clamp 60

Handling a variation of group diameters of wiring bundles, new strap-type harness clamp installation has been developed by **Tinnerman Products**, Cleveland, to permit a greater flexibility of application. To fasten



clamp, strap is looped around bundle of wires and slipped under loose-locking roller in bracket. Strap is then pulled tight in opposite direction and roller is then forced into locked position. To release, two heads of roller are pressed to snap it back into free position. Strap, made of Neoprene-coated fabric to withstand minus 65 to plus 160 deg., is fungus resistant.—**AVIATION, June, '46.**

Lightweight Plastic 61

Envisioned for use as strong, lightweight cores in airplane floor panels, tail assemblies, wing structures, and for other uses, new foamed plastic is made by **E. I. du Pont de Nemours & Co.**, Wilmington, Del. Lighter than cork, maker states it has virtually same insulating properties as cork, balsa wood, and other rigid insulating materials. When this cellular cellulose acetate material is bonded between two panels of metal, wood, or another plastic, it is said to be non-compressible except under extreme pressures. Its heat resistance is such that thermosetting resins can be used to cement it. Plastic is now made in strips 3½ in. long and ⅝ in. thick. Thicker and wider pieces will be made soon, but present strips may be glued together to form thick sections. Material may be tooled or shaped with any woodworking machinery.—**AVIATION, June, '46.**

Motor Resists Dust.....62

Available in standard explosion-proof and dust-explosion-proof types from 1 to 1,000 hp., new totally enclosed fan-cooled motor designed for use in dusty, dirty, and corrosive atmospheres, has been added to line of "Tri-Clad" induction motors made by **General Electric Co.**, Schenectady, N. Y. Short in length, motors have low starting current, with balanced design, making units suitable for full voltage starting.—**AVIATION, June, '46.**

Metal Cleaner 63

Permitting a choice of several cleaning cycles, new conveyorized two-dip immersion vapor degreaser made by **Detrex Corp.**, Detroit, is designed to handle small basketed parts. Two methods of cleaning are offered. One is immersion-vapor cycle. Work being cleaned is dipped in hot solvent in first chamber and is moved through vapor in second. Other selection is vapor-immersion-vapor cycle, where solvent level is held low in first chamber allowing accumulation of oils and grease as in one dip concentrator. Conveyor then moves through hot solvent in second chamber and then through solvent vapors in second phase. Boil-rinse-vapor cycle cleans work in

Improvement of the physical properties inherent in a grade of steel continues throughout the forging process. Rolling, hammering, or upsetting operations compact millions of metal fibres to obtain maximum tensile and torsional strength—highest fatigue resistance. These qualities underwrite dependable performances.

Wyman-Gordon forgings from five to a thousand pounds . . . engineered to meet your own individual requirements.

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Forgings of Aluminum, Magnesium, Steel

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HARVEY, ILLINOIS - DETROIT, MICHIGAN

Common Sense Assembly Engineering

Cuts Unit Assembly Cost 8¼¢... Greatly Improves Product

BEFORE Enameled steel knob on bracket of old model "Quintuplet" Can Opener cost 4½¢ to 5¢ . . . two large and two small special bracket rivets 1⅔¢ each. On opener, turning handle was soldered to cutter wheel, prevented easy replacement. TOTAL ASSEMBLY COST 11¢.

AFTER Plastic Knob (2½¢) replaced steel knob. Attached with P-K Hex Head Type "Z" Self-tapping Screw, which also serves as locking and locating device, eliminating one large bracket rivet. Improved, detachable crank handle on opener is fastened by two Hex Washer Head Type "Z" screws, making replacement of cutting gear easy. One Hex Head Type "Z" Screw attaches second plastic knob to crank handle. Screws are driven with a power press driver. TOTAL ASSEMBLY COST 2¾¢.

Here's a case where "looks" belie the facts. The new model "Quintuplet" Can Opener made by the Cahil Manufacturing Company *looks* like a costlier assembly job than the old one – but it isn't. It's 8¼¢ cheaper, thanks to common sense assembly engineering and P-K Self-tapping Screws.

By eliminating hand operations and high cost special parts, and by combining the functions of other parts, P-K Assembly Engineers helped this company achieve "an outstanding improvement in the product from the user's standpoint, plus considerable savings in time, labor, and material" according to Mr. J. A. Cahil, President.

Such savings are not uncommon where Parker-Kalon fastenings are used – they often run as high as 30% to 50% through the elimination of needless tapping, bolting, riveting, and inserts.

Can you apply these benefits in your assemblies? In seven out of ten assembly jobs submitted to us, the answer is "Yes". A P-K Assembly Engineer will call and help you find all possible savings – or, mail assembly details for recommendations. Parker-Kalon Corp., 200 Varick Street, New York 14, N. Y.

SOLD ONLY THROUGH ACCREDITED P-K DISTRIBUTORS

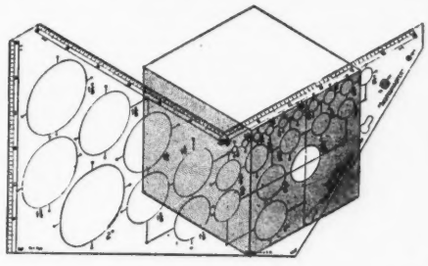
PARKER - KALON P-K SELF-TAPPING SCREWS

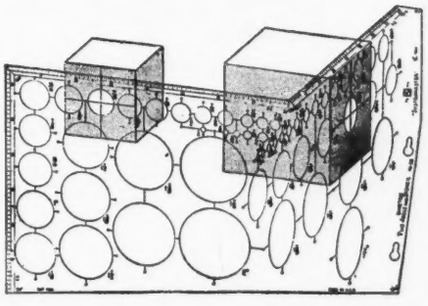
FOR EVERY METAL AND PLASTIC ASSEMBLY

solvent at a boil temperature, at a rinse temperature and in vapor. Work is loaded at one end, carried through cleaning cycle, and returned through upper hood to same end of machine for unloading. Known as 500-C-1, degreasers have capacities of 2,000 to 4,000 lb. per hour. There are eight basket sizes ranging from 8 x 18 x 6 in. to 18 x 36 x 12 in.—AVIATION, June, '46.

Stencil Drafting Instruments.....64

Draftsmen may make isometric or dimetric drawings by using two new "Instrumaster" stencils, without using other devices. Both are cut from clear plastic stock .040 in. gage, with graduations and lettering debossed on lower side. Made by Instrumaster Industries, Greenwich, Conn., stencils provide inch graduations at

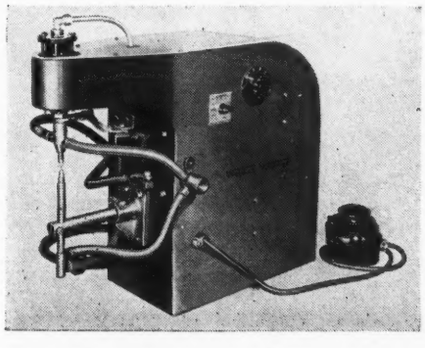




full scale along one vertical and two slanted edges. These edges represent correct directions of isometric and dimetric axes. Each stencil has 27 ellipse openings representing in individual projections, circles from ⅛ to 2 in. dia. By placing one edge against T-square, graduated edges as well as ellipse openings assume required position within drawing. Lines and small holes indicate center lines of ellipses. Ellipse sizes are indicated by size of circle to be represented, not by major axis. Same type stencils are made with ellipses ranging from 2¼ to 4½ in.—AVIATION, June, '46.

Spot Welder 65

Air-operated foot-controlled electronically timed, and with adjustable pressure switch, new bench type spot-welder, announced by Weldex, Inc., Detroit, is 3 kva, 220v., 60

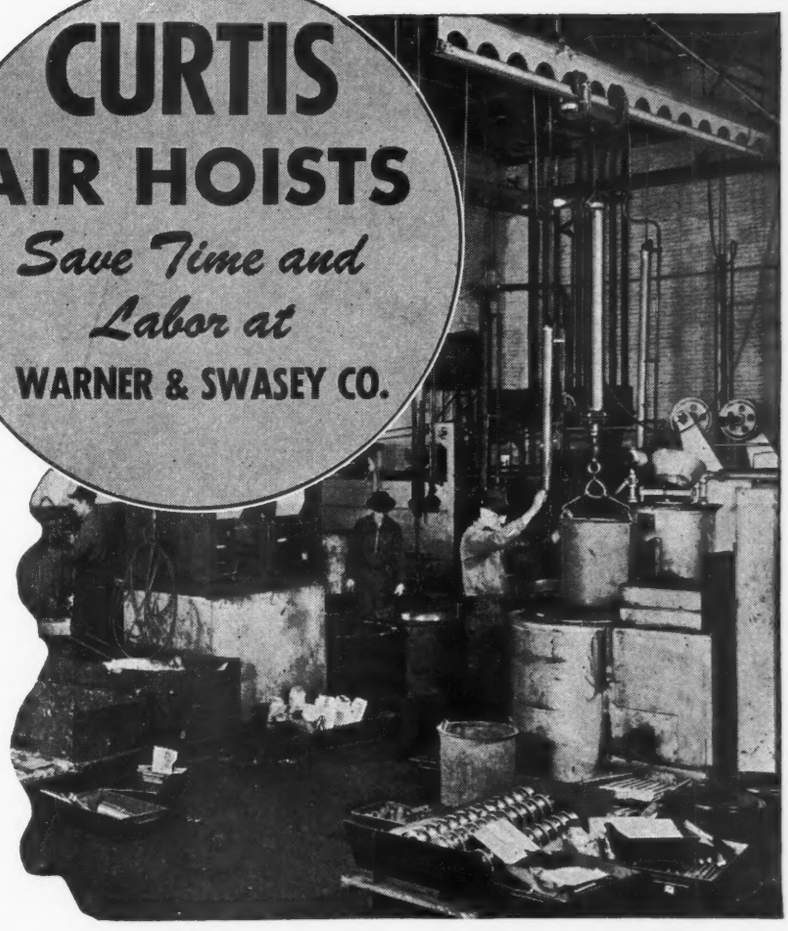


cycle, single-phase unit. Known as Model 263-A, it is recommended for welding of lightweight metals up to 18 gage. Machine is 21 in. high, 10 in. wide, and 23 in. deep. Weight is about 135 lb.—AVIATION, June, '46.

Bright Dip 66

Developed to form a corrosion resistant finish on surface of metal, "Iridite Bright", is chemical treatment stated to produce mirror-bright transparent chromate film on zinc or cadmium plated parts. No electric

CURTIS
AIR HOISTS
Save Time and Labor at
WARNER & SWASEY CO.



Curtis Air Hoist used in operating the Cleveland Tramrail System in the heat-treating department of Warner & Swasey Co., Cleveland.

It's another example of a well-known company relying on Curtis air-operated equipment to speed production, save time and labor, too. Curtis Air Hoists offer the following advantages to any company concerned with any lifting, pushing or pulling operation:

- **Low first cost — lowest operating expense.**
- **Smooth, fast, accurate control of load.**
- **One-man or one-woman operated.**
- **Finger-tip control.**
- **Light weight — pendant, bracketed or rope-compounded types.**
- **Cannot be overloaded.**
- **Capacities up to 10 tons.**

Find out how Curtis Air Hoists, Air Cylinders and Air Compressors can save man hours, cut costs in your plant. Write for Bulletin C-7.

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Please send me Form C-7 on Curtis Air Hoists and Air Cylinders; also Curtis Air Compressors.
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BUT A LAMINUM SHIM doesn't stop there. You get *certainty* of accuracy in factory assembly of gears and bearings of all kinds (with less supervision) plus the ease with which adjustments in service may be made with the same Laminum shim. Advantages too great to be minimized. Bulletin and application photo chart on request.

Laminum shims are cut to your specifications. For maintenance work, however, shim materials are sold through industrial distributors.

Laminated Shim Company, Inc.
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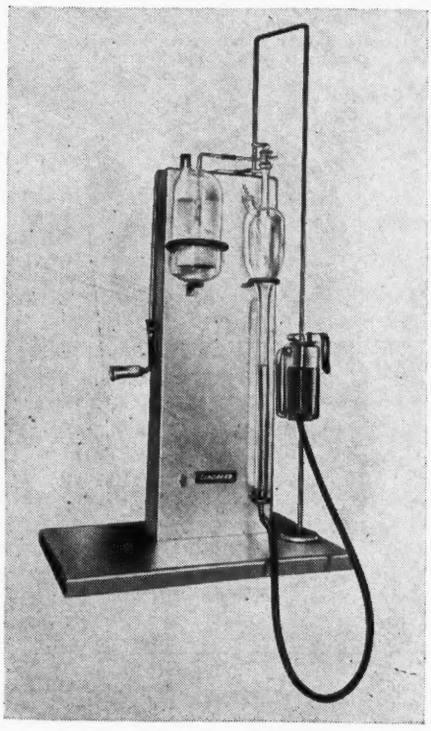
LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

2219

current is used in process. Parts being treated are immersed in solution for 5 sec., and rinsing and drying follows. Product is made by **Rheen Research Products**, Baltimore.—**AVIATION, June, '46.**

Carbon Determinometer 67

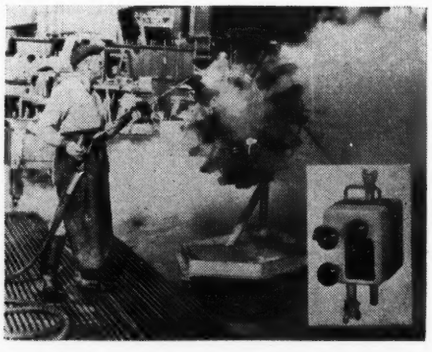
For use in analyzing carbon in iron, steel, heat resisting steel, stainless steel, and other materials, new volumetric type carbon determinometer, made by **Lindberg Engineering Co.**, Chicago, has burette mounted in front of a fluorescent light. Burette is water jacketed and graduated



for 1 gram and ¼ gram samples. Chamber, which permits absorption in two passes and for many alloys in one pass, combines use of glass tubing and glass beads. Friction clamp holds leveling bulb at any point. Micrometer screw is used for zero adjustment.—**AVIATION, June, '46.**

Steam Cleaning Unit.....68

Suitable for use in cleaning engine parts, and for other shop uses, new Hydro Steam unit is designed to operate from any steam line of 80 to 150 lb. pressure with a ¾ in.



valve outlet. Maker is **Turco Products Co.**, Los Angeles. There are three manual controls to vary temperature, quantity of solution, and nozzle pressure. Unit can be adjusted to deliver high temperature, penetrating spray, or warm spray. There are no moving parts, pumps, pressure tanks, motors, or electrical connections. Weight is 28 lb.—**AVIATION, June, '46.**

Assembly Bin Hopper.....69

Designed to increase capacity of assembly bins nearly four times, to save bench space, and reduce interruptions of work, new bin hoppers made by **Stackbin Corp.**,

New Protek-Plug Assures Greater Engine Protection

The new CECO Protek-Plug assures a new high standard of protection against the presence of moisture within aircraft engine cylinders. And it delivers this greater protection at a really low cost.

It has five new, improved features which increase its over-all effectiveness and length of life . . .

The silica gel is enclosed in a glass chamber, completely to eliminate moisture penetration from outside . . . giving a clearer picture of moisture conditions inside the cylinder.

The glass is seated in a metal base to strengthen the plug, and to give a tighter fit in the eylinder.

Standard size spark-plug wrenches fit the metal hex base to speed installation.

The brass cap fits tightly over the open end, keeping the Protek-Plug tightly sealed until it is placed in service.

The moraine filter replaces the paper strainer formerly used in the days of wartime shortages.

Write for full information on the new improved Protek-Plug to the address below.

CARBURETORS FUEL PUMPS PROTEK-PLUGS

CHANDLER-EVANS CORPORATION

WEST HARTFORD 1, CONNECTICUT, U. S. A.

CECO

The Difference Between "We Think So" and "We KNOW So"

Permoflux Speakers

...are Engineered for Application in this Stalactite Acoustical Chamber

In this completely soundproof room, asymmetrical walls and carefully designed mass-interval baffles effectively reduce troublesome resonant harmonics and reflected sound to an insignificant value. Response curves are plotted which represent true performances so that Permoflux engineers can say "We *Know* So." Its use at Permoflux is characteristic of the many factors which make it possible to substantiate the fact that Permoflux Speakers provide the finest possible sound reproduction.

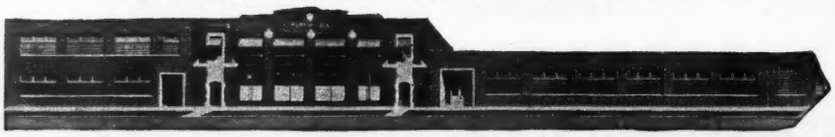
SEE US AT THE CHICAGO TRADE SHOW—BOOTH 32

TRADE MARK

PERM-O-FLUX

PERMOFLUX CORPORATION

4900 WEST GRAND AVE., CHICAGO 39, ILL.

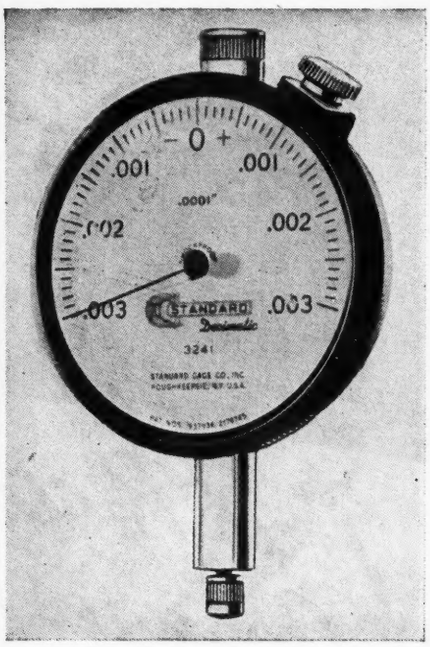


PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS

Providence, R. I., are tapered toward front to form semi-circle. Sloping floors feed parts toward front. Hopper is made of sheet steel with welded construction. When attached to bin it becomes rigid and nests without fastening tools.—**AVIATION, June, '46.**

Decimal Tolerance Indicator.....70

Having dial markings in decimals and therefore comparable to blueprint tolerances, new series of indicators has been introduced by **Standard Gage Co.**, Poughkeepsie, N. Y. Advantages are stated to include modified range on dial, elimination



of possibility of failure to notice complete revolution of dial, freedom of whip and waver of hand, consistent repeatability, and operation under low tension. Mounting dimensions are in accordance with American gage design standards. Indicators are made in both English and metric units.—**AVIATION, June, '46.**

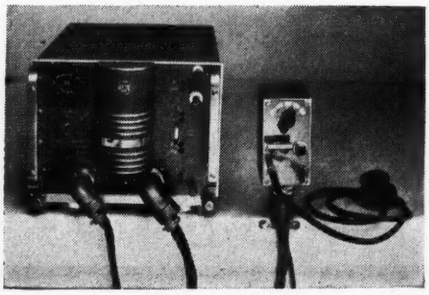
Two-in-One Hammer 71

Developed for use wherever a solid blow must be struck without injury to work, new dual rubber-and-steel headed hammer is made by **Dan Morey,** Los Angeles, for use in plane factories and repair bases. Rubber head is replaceable by pressing on new head in vise. Shank and head is drop forging, heat treated, and polished. Soft head is of 2-in. dia. and made of truck rubber. Steel head is of 1½ in. dia.—**AVIATION, June, '46.**

Electrical Appliances

Four-Channel Transmitter 72

Designed to supply 50w. of output power, new four-channel transmitter, Model No.



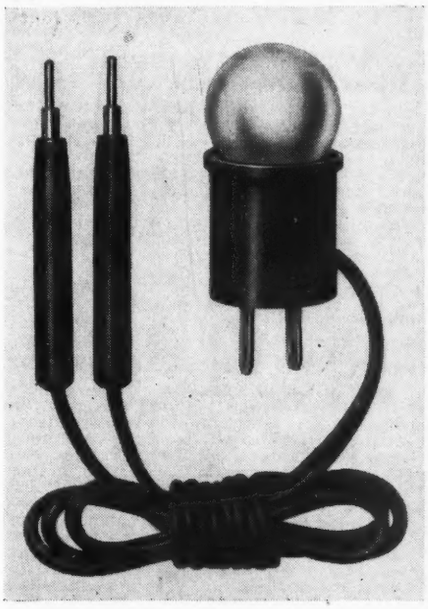
AVT-49, made by **Engineering Products Div., Radio Corp. of America,** Camden, N. J., permits selection of any one of four pre-tuned frequencies by turn of a switch. Transmitter and its dynamotor are contained in shock-mounted metal cabinet. Only additional unit is master remote control box, which may be located anywhere within 15 ft. of transmitter. Frequencies are available within range of 3 to 13 mc. Instead of fuses, new unit has manual re-set type of thermal circuit breaker mounted on front panel. Designed for either 12 or 24v. operation, transmitter does not have to be rebuilt if transferred from one plane to another of different voltage. Conversion involves only changes of dynamotor, circuit breaker, and control box pilot lamp. Dual voltage relays are used throughout. Unit weighs about 40 lb.—**AVIATION, June, '46.**

Molded Coil Forms.....73

Made with anchored hairpin wire leads, molded bakelite coil forms announced by **Electronic Components Div., Stackpole Carbon Co.,** St. Marys, Pa., have uses ranging from universal and tapped universal windings to solenoid windings, antenna or coupled windings, and iron cored I-F transformer or coupled coils. Standard types include forms with coaxial leads each end, single hairpin leads each end, single hairpin leads one end, double hairpin lead other end, and double hairpin lead each end. If desired, coils may be wound on separate tubes and slipped over forms, or winding may be done on forms direct. Where required, forms are supplied with molded iron sleeve cores.—**AVIATION, June, '46.**

Test Lamp 74

Designed for checking wiring, switches, relays, coils, resistors, starters, fuses, gen-



erators, ignition systems, also lamps for short circuits, open circuits, and grounds, new plug-in test lamp is announced by **Hanlan Co.,** Los Angeles. It operates on any 110v. outlet.—**AVIATION, June, '46.**

Aircraft Parts & Field Units

Fueling Ladder 75

Designed to accomodate any large plane, new fueling ladder made by **Hammond Mfg. Corp.,** Huntington Park, Cal., is made of steel tubing. Employing roller bearings, front wheels have 8-in. casters with molded tire, while 12-in casters are used on back wheels. Operated by a hand winch, ladder extends from 6 ft. 7 in. to 16 ft. Unit has safety locking pin and dogs, and steps have

SPECIFIED FOR ALUMINUM CLEANING

A New Specially Designed Material — Now available for cleaning aluminum aircraft is Kelite Formula 33. Aluminum oxide coatings and discolorations are quickly—thoroughly removed. Time, labor and materials used for subsequent polishing or painting are reduced to a minimum with *new* Formula 33.

A New Simplified Method — Kelite Formula 33 used in conjunction with *Kelite KDL No. 28* offers an ideal combination for aluminum cleaning. KDL No. 28 effectively removes dirt, grease and films. Kelite Alu-Clean provides the final polish. Alu-Clean produces a bright, even, lustrous finish—no smut, scratches or swirl marks.

A New Standard in Aircraft Cleaning — Let the Kelite Service Engineer show you how these Kelite Materials properly used under Kelite pH Control can establish a new high standard in aluminum cleaning. His training and experience in the aircraft field will save you time and money. His services are available upon request.

For further information call your local Kelite office or write direct to:

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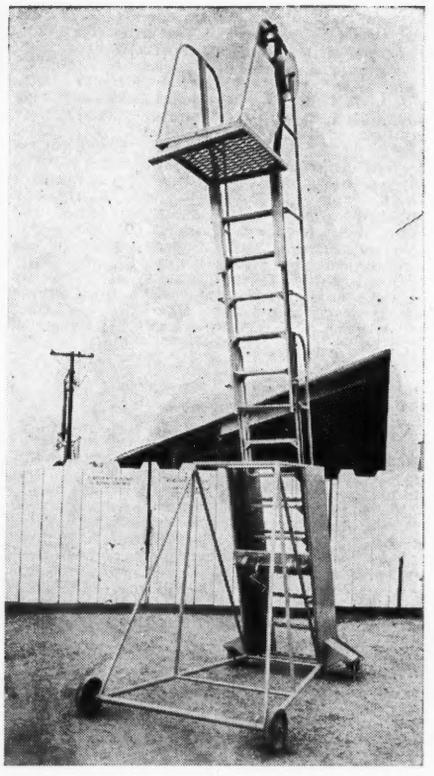


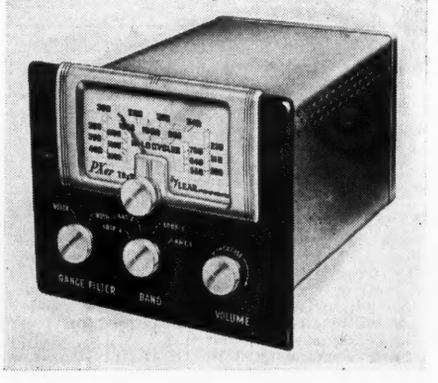
safety tread. Nozzle of hose is held by sheave and is raised with stand. Total weight is about 600 lb.—**AVIATION, June '46.**

Reflector Floodlight Bulb.....76

Useful for emergency field work, repairs, and other applications, new floodlight made by **Wabash Corp.**, Brooklyn, N. Y., has silver reflector lining hermetically sealed inside, with filament mounted at focal point. Light beam, moderately concentrated between 0 to 60 deg. zone, feathers away to diffusion at edges. Bulb is of 5 in. dia. and 6½ in. long and can be used in any standard socket, swivel type socket, or recessed ceiling fixture. Stated to have a life of 1,000 hr., floodlight is available in 100, 150, 200, and 300w. sizes.—**AVIATION, June, '46.**

Aircraft Radio 77

Lear, Grand Rapids, Mich., announces Model TR-2B aircraft radio, designed to cover beacon and commercial broadcast frequencies, furnishing two way communication, avigational aid on radio ranges, entertainment programs, and direction finding when tuned to standard broadcast stations. Weighing 10 lb., set includes transmitter-receiver, power supply, head phones, and microphones. It is divided into two units, with control unit mounted on instrument panel, and power unit remotely located in plane. Transmitter is crystal controlled oscillator, power amplifier, and modulator, and has output of 12w. Receiver is superheterodyne with a stage of radio frequency amplification. Receiver antenna is stated to have sensitivity of 5mv. per meter with 4-to-1 noise ratio at 50 mw. output on one



ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

In writing, emphasis upon specific aviation applications of newly marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

New Products Editor, AVIATION
330 W. 42d St., New York City 18

band, and on other band a sensitivity of 5 to 10 mv. with noise ratio of 4-to-1. Sensitivity is 50 to 80 mv. when used as aural-null direction finder, employing a loop.—**AVIATION, June, '46.**

Metal Propeller 78

New metal propeller, "Met-L-Prop", made by **McCauley Corp.**, Dayton, Ohio, is described as shortening takeoff run, increasing rate of climb, and enabling faster cruising speed without sacrificing takeoff performance. Designed for small personal

planes, this thin-sectioned light aluminum airscrew is stated to give extra long life and reduce maintenance expense.—**AVIATION, June, '46.**

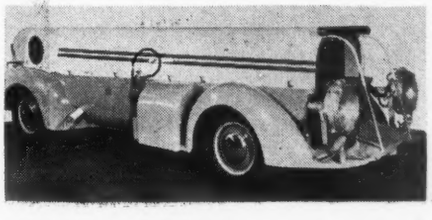
Beam Controlled Light.....79

Developed to permit safe landings when ground visibility is down to ⅜ mi., new beam controlled light is made by **Line Material Co.**, Milwaukee. Lights, used on

both sides of approach or runway, are stated to be glare-free high intensity units. They are designed to be used on a fixed focus with brightness controlled for average visibility, or they may have a remotely controlled variable beam for operation under lower limits.—**AVIATION, June, '46.**

Power-and-Service Truck 80

Motorized truck designed to deliver 12 and 24v. electric power to airplanes, and also to handle water, alcohol, oil, and air,



POWER

FOR GROUND SERVICING WITH THE NEW ONAN

AIRCRAFT ENERGIZER

The new Onan Energizer, incorporating in its design all the desirable features specified by five major airlines, meets the requirements of large transport planes for more auxiliary power on the ground.

This unit is completely self-contained—protected by a streamlined housing. A 5 KW generator, supplying either 12 or 24-volt output, is direct connected to an Onan 2-cylinder, air-cooled, gasoline engine. Four heavy-duty batteries are floated across the line. The plant has a continuous rating of 200 amperes at 24 volts, and a maximum 5-minute output of 600 amperes.

The Energizer supplies dependable power for ground servicing of radio equipment, cabin lights, heaters, main engine starters and other electrical loads.

Mounted on a rubber-tired 3-wheel dolly, this Onan unit is easily moved and operated by one man.

PRIME MOVER: 10 H.P., 4-cycle, two-cylinder, air-cooled Onan CK engine.
GENERATOR: 4-pole, shunt-wound, commutating pole.
OUTPUT: Continuous 200 amperes at 24 volts. Maximum of 600 amperes for 5 minutes. Generator operates at either 12 or 24 volts.
HOUSING: Sheet steel, streamlined. Storage and hand phone compartments. Hinged side panels.
DOLLY: Ball-bearing wheels. Two 4:00 x 12 pneumatic tires. Parking brakes. Swivel wheel.
STARTING: Electric push button.
ACCESSORIES: Recessed, illuminated control panel. Automatic voltage selector relay. Two types of fire extinguishers. One 10-foot cable with aircraft type plugs for both 12 and 24-volt supply.
WEIGHT: 852 lbs. (including four 6-volt storage batteries).

WRITE FOR COMPLETE DETAILS.

•

Onan Electric Plants are available in sizes from 350 to 35,000 watts.
ALTERNATING CURRENT: 115 and 230 Volts, 50 and 60 cycle. Single-phase for all capacities. 3-phase for models 3 KW or larger. Other voltages and frequencies available.
DIRECT CURRENT: 115 and 230 Volts, 600 to 10,000 Watts. 6, 12 and 32-Volt Battery Chargers to 3500 Watts.

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STANDARD SHAPES OF
REVERE MAGNESIUM
MAKE THESE BODIES 1500 lbs. LIGHTER

BUILT BY Barry and Baily Company in Philadelphia *without previous experience in working with magnesium*, these panel bodies for American Stores Company weigh approximately 1500 pounds less than similar bodies of steel!

Standard shapes of magnesium alloy, especially engineered by Revere and readily available from stock, make possible this remarkable advance in truck bodies. Now, for the first time, body builders and fleet operators can use magnesium with the same ease as steel. All sheet metal forming is eliminated through this Revere development. Structural members are all pre-designed in accordance with the engineering properties of high-strength magnesium alloys. None but familiar methods of fabrication and assembly are involved . . . clamping, drilling, riveting.

Full Latitude for the Body Designer. Bodies built with these standard materials may be large or small, may include any type of floor desired, may conform to individual designs, may be mounted on any make of chassis.

From the illustrations of this body under construction by Barry and Baily, you can see how simply and neatly the specially engineered Revere parts go together. The standard members consist of extruded floor beams, corner posts, crown sill sections, side posts and roof carlines, structural angle section, roof corner castings, and sheet for all exterior panels.

Dent-Resisting Corner Post. Two features are especially noteworthy and are shown here in detail. One is the composite corner post design. The inner post is a rugged member with a protrusion at its center running its entire length. This supports the strong outer shell at its most vulnerable point, and entirely eliminates the need for hand-fitted wooden reinforcing blocks. Because this post provides a smoothly rounded corner, the sheet for exterior paneling need only be fastened flat between the inner and outer members by means of rivets.

A Rugged Roof Rail. Not only is the roof rail exceptionally sturdy to resist abnormal punishment in service, but it securely unites side, end and roof panels into a rugged, unified structure of excellent appearance because of the generous radii employed. A decorative top trim designed as a scuff rail serves to ward off overhanging obstacles that might damage rivet heads. The roof corner is a massive magnesium alloy casting. This, as well as side posts, roof carlines and reinforcing angle sections, are all joined to the roof rail with machine screws or bolts.

Let Revere Help Lighten Your Equipment. Revere's standard magnesium alloy shapes have been engineered to make the building of ultra-light panel bodies simple, easy and inexpensive. But truck bodies are only one type of equipment which Revere magnesium can lighten. In collaboration with your own engineers, a Revere Technical Advisor will gladly assist in the application of magnesium to your products. That is the way to get more payload into your transportation equipment . . . on the ground or in the air.

For full details on Revere's standard magnesium alloy shapes for truck bodies and on other Revere magnesium products, get in touch with the nearest Revere office.

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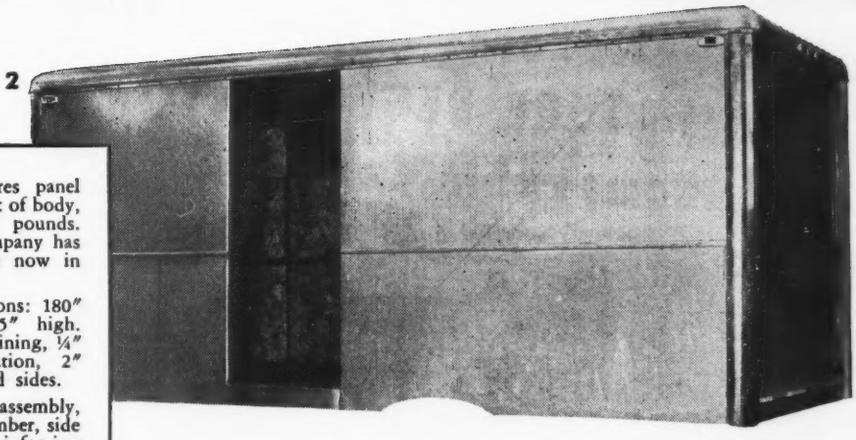


2

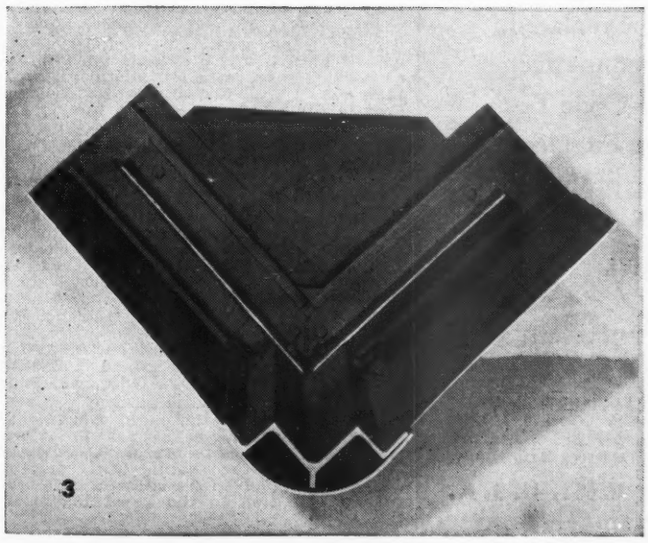
(1) 5-ton American Stores panel truck. Finished weight of body, approximately 2100 pounds. American Stores Company has two of these trucks now in service.

(2) Inside body dimensions: 180″ long, 86″ wide, 75″ high. Flooring, 1⅛″ oak. Lining, ¼″ fir plywood. Insulation, 2″ fiberglass in roof and sides.

(3) Detail of roof rail assembly, showing roof rail member, side post, roof carline, reinforcing angles and corner casting as seen from inside.

(4) Detail of corner post assembly showing how side and end panels are riveted to the composite corner member.

1



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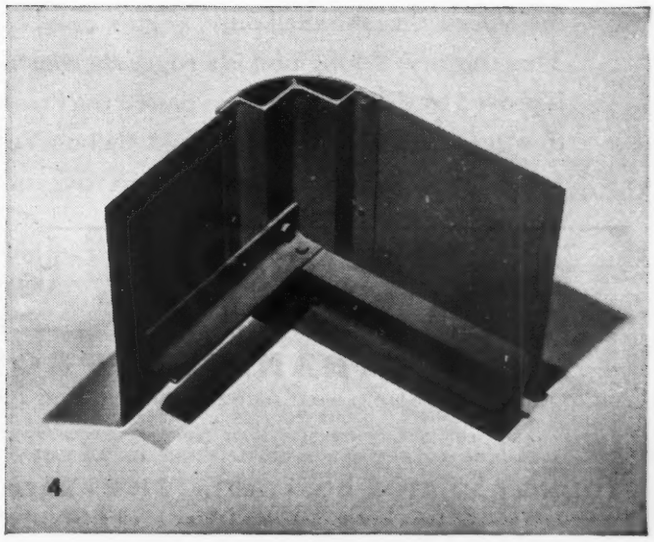

4

● It's here! An oil cooler with a removable core. Young's newest contribution to the aircraft industry is an Oil Temperature Regulator, the tube bundle of which may be easily separated from the shell for periodic inspection, cleaning and repair by the removal of two bolts. This revolutionary feature . . . long awaited . . . permits frequent removal of sludge, thereby improving operating efficiency and lengthening the life of the cooler. Replacement costs are reduced to a new low since either the shell only, or core only, can be replaced. That this new Young unit is a ruggedly constructed product, is proved by the fact that it has passed the Pressure-Cycle Test that goes far beyond normal usage. Call on Young Engineers for assistance in reaching a solution to *your* cooling problems.

YOUNG Young Quality

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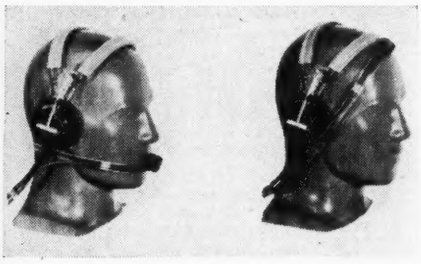
nitrogen, and oxygen at 2,000 psi., is offered by **Couse Manufacturing, Inc.**, of Newark, N. J. Chassis-body can be separated into two parts for easy overhaul or for shipment of unit by air. Power delivery: 12v. planes, 400 amp., generator, or 400 amp, battery; 24v. planes, 400 amp., continuous, or 800 amp., intermittent.—**AVIATION, June, '46.**

Pilot Lip Microphone.....81

Featuring new head harness design, lip-type, carbon microphone, weighing 6/10 oz. has been developed by **Aviometer Corp.**, New York City. Headphone supports micro-



phone free of face, keeping phone at point of optimum speech reception regardless of movement of operator. Unit was recently adopted by Swedish Air Lines.—**AVIATION, June, '46.**

Recent Books

AIRSHIP OPERATION, WORLD WAR 2. Available from USN Base, Lakehurst, N. J., 56 pages. $.50.

This booklet renders a graphic account of the part played by lighter-than-air naval craft in the late war, covering the period from Dec. 7, 1941, to Sept. 1945. Profusely illustrated.

RUBBER IN ENGINEERING, Chemical Publishing Co., Brooklyn, N. Y. 267 pages. $5.50.

Prepared under the direction of the Controller of Chemical Research of the Ministry of Supply and the Directors of Scientific Research of the Ministry of Aircraft Production in Britain, this book treats of rubber in modern engineering. The problems of both manufacturer and consumer are discussed in detail. Theoretical and practical data are presented to demonstrate how certain variables, ignored in other engineering materials, are of fundamental importance in the case of rubber. The book contains many tables, graphs, and charts.

THE HOW OF THE HELICOPTER, by Alfred H. Stevens, Jr. Cornell Maritime Press, N. Y. 58 pages, illustrations. $2.00.

Graphically illustrated history and background of the helicopter. Though primarily intended for younger reader, the average adult will, beyond question, find this book interesting and informative.

YOUR POST-WAR PLACE IN AVIATION, by Russ Brinkley. The Aviation Press, Inc., New York City. 96 pages. 50c.

This is an inexpensive, newstand type book offered as a handy civil aviation guide for ex-service men, student pilots, airminded high school students, and others seeking a spot in the aviation field.

AIR WORDS, A Popular Aviation Definitionary, edited by Fred Hamann. Superior Publishing Co., Seattle, Wash. 61 pages. $1.50.

Those wishing a reference covering the language which flyers speak will find this dictionary of aviation argot comprehensive. The entire history of aviation has been covered, usages from every period in its development being found in Mr. Hamann's book.

THE BUSINESS LAW OF AVIATION, by Gerold O. Dykstra and Lillian G. Dykstra. McGraw-Hill Book Co., N. Y. 523 pages, index. $5.00.

This volume is a thorough, workmanlike combined text and case book in aviation law. Its purpose is to present a convenient compilation of the leading court decisions which have involved aspects of aviation and to call attention to the governing federal

and state statutes. Analyses and discussions of aeronautical statutes and court decisions are written in simple, concise language. Special attention is given to recent advances which give new bearing, and an entire chapter has been devoted to international aspects.

Industry Publications

ATA is issuing a review of air transportation problems in U. S. delving into many problems faced by carriers. Copies may be had by writing ATA, 1515 Massachusetts Ave., N.W., Washington 5, D. C. . . . American Society for Testing Materials released 1945 supplement to its Book of ASTM Standards. Hq. are at 260 So. Broad St., Philadelphia 2. . . . CAA has available "Statistical Handbook of Civil Aviation," replete with facts, graphs, and charts covering past year's activities; also being distributed is new consolidated "Airman's Guide," covering Notices to Airmen, Directory of Airports, and Air Navigation Radio Aids.

U. S. Naval Air Transport Service has compiled a comprehensive history of its activities entitled, "The Role of NATS in the Pacific War" . . . "Reply of the ATA to the National Transportation Inquiry" answers queries put by House of Representatives Subcommittee on Interstate and Foreign Commerce . . . "The Economic Advantages of Integrated Sea-Air Transportation" is new booklet put out by Sea-Air Committee, National Federation of Shipping, Inc., 2660 Woodley Road, N.W., Washington, D. C.

"National Policy for Aviation" covers an integrated program for future aviation development. It is put out by National Planning Assn., 800-21st St., N.W., Washington 6, D. C. . . . PICAO, Montreal, Canada, has issued a booklet, "What is PICAO?", explaining the committee's functions . . . "How Can the Air Cargo Carrier Use the Services of a Freight Forwarder?" is a pamphlet issued by Edward S. Evans Transportation Research, 435 Woodward Bld., Washington 5, D. C.

A large number of reports on scientific and industrial aviation information obtained mainly in Germany and German-occupied territories have been released for sale by Office of Publication Board, Commerce Dept., Washington 25, D. C. Materials, processes, products, development work, and other technical material are encompassed in detail. . . . A booklet containing three authoritative considerations of airport developments is available from Airport Div., American Road Builders' Assn., 1319 F St., N.W., Washington 4, D. C.

Follow-Up Clinches Sales

(*Continued from Page* 51)

follow through in an effort to arrange financing, or to sell flying time, or to supply some other less expensive product or service. He quickly loses interest in the prospect and neglects to develop other lucrative possibilities.

Many a dealer sells only to those who offer the least resistance during first contact. He skims the cream of the territory, and then is through. Thus he continually loses an investment in time, energy, and expense—wastes it by giving up too soon on prospects who require persistent follow up. Records in all lines of selling indicate that most sales are closed on fourth and later calls.

Business veterans profit by following up every potential prospect—hanging on with the tenacity of a bulldog until they are thoroughly convinced a sale of some product or service is impossible. These sales experts have come to recognize, in every day's work, the danger of letting mental deflectors swerve them from a predetermined course of action. Temptations to stop plugging must be brushed aside.

Through experience they have learned that in normal times, four out of five airplane sales are financed on easy monthly payments, eliminating the need for abnormal cash outlays, also that eventually the present owner's airplane will wear out and he will buy a new one, even though he procrastinates at the moment. The experienced dealer knows that if he persists long enough—on a flight student, a visitor, a businessman, or other person in the community—he will close an order. And he knows that his average competition will not persist, thus finally giving him the inside track.

On the other hand, the inexperienced dealer is apt to be deflected in his follow-ups and not realize that persistence of purpose is one of the golden keys to successful selling. Here are seven of the fallacious philosophies commonly voiced by the inexperienced dealer, with the weakness in each pointed out:

1. *"Making sales calls takes too much time. I'm too busy giving flight instruction, keeping the books, handling customers, and managing my business to get away for sales calls."* Following up on sales does take time, but it will pay off in future business. You should analyze your sales schedules to determine what duties can be transferred to someone else, even part time, so that your efforts may be expended in more profitable and productive work. A definite amount of time should be devoted to selling students and other prospects who visit the airport. These potential buyers should be taken care of before looking for others.
2. *"I'll never be a good salesman because people turn me down."* That's because you are new in selling. After a while your failures will slip off your back like a summer breeze. You'll expect turndowns, according to the law of averages—and by the same law, you will make sales.
3. *"There's too much sales resistance to this plane. I'd like to change to one that is more in demand."* Remember, your earnings rise in direct proportion to the resistance you overcome.
4. *"My territory is saturated. I want a bigger area that will give me more prospects."* Are you guessing, or do you really know the exact saturation of your present territory? Have you really tried to sell to all possible prospects, or have you just skimmed the cream?
5. *"I'm going to get another franchise because I'm not getting the proper cooperation from the factory or my distributor."* You may or may not be getting enough cooperation. Go to the proper person and check carefully on that. Perhaps the extent of the help you expect cannot be realized because the profits on the plane or product do

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EXACTLY THE SAME!

Precision dies and precision methods at Booth's produce felt parts of consistent accuracy.

Add to this our high standards of quality plus prompt, interested attention to all orders, small or large, and you've a picture of the kind of service you get from Booth.

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APPLICATION CHART AND SAMPLE KIT... *contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)*

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PRECISION CUT FELT PARTS

The Raytheon Radiophone is on its way!

When you think of radio for your plane, investigate the Raytheon Radiophone. Note its light weight, its many distinctive points of difference, its utter simplicity, its outstanding features. You'll agree that it's a private pilot's dream come true.

Created by radio engineers who fly their own planes, the Raytheon Radiophone meets both routine and emergency needs of the private pilot in thoroughly effective and practical ways. Here, in one compact unit, are the means of ready conversation between pilot, control tower and range stations . . . clear "beam" signals . . . standard broadcast reception. And prices have been kept remarkably low.

ALL THESE FEATURES

For ease of servicing, entire unit can be removed and replaced with another Radiophone in a matter of minutes. Receiver performance comparable to commercial airline standards. Crystal controlled transmitter never drifts off frequency. Power output of transmitter—16 watts. Two vibrators operate independently—easily switched while in operation. Built-in loading coils. Units for either 6 or 12-volt operation. Height 5", width 5¼", depth 14¼". Weight 14 pounds. Equipped with range filter switch, push-to-talk microphone, transmitter output indicator, long life Raytheon Tubes and provision for direction finder loop. Ample power for loudspeaker operation.

BELMONT RADIO CORPORATION
A Division of Raytheon Manufacturing Company
5955 West Dickens Avenue, Chicago 39, Illinois

not justify it. If more cooperation would help sell more planes, the company is hurting itself if it withholds such aid.

6. *"There's no use in following up that prospect further—he won't buy until the first of the year."* That is one of the oldest excuses for not buying known to salesmen. Ignore such statements and keep after the sale.
7. *"Without lifting a finger, I can sell all the airplanes the factory can send me."* Currently, this feeling is all too prevalent due to the pent up demand for new airplanes. If your first closures come too easily, you may take on a deflector that may affect your sales record in the long run, and soften you so that later you will find it difficult to meet real sales resistance. Don't let up.

By what program can the dealer develop sales-clinching follow-up habits? First, a policy of persistency must be established, then a mechanical routine must be set up whereby the dealer automatically follows through.

A mechanical method for following up prospects involves telephone calls, post cards, and letters. Keeping in touch with the prospective purchaser is vital. The dealer should keep his goal, his quota, and his program graphically in front of him. It should work for him every day, reminding him of what he has previously planned to accomplish, and showing him just how far he has proceeded. A dealer often fails to carry through to a successful conclusion because he forgets what he started out to achieve.

A unique and effective follow-up system is covered in the five-point prospect card (see illustrations) used by Anderson Air Activities, of Milwaukee. It not only points out where to find prospects, but keeps a detailed check on the progress of the sale. There is no let up until every one of the methods outlined on the card has been checked off.

The dealer will find that this system, or a similar one, will get him results—and it will help him to finish what he has started.

Rocket Research

(*Continued from page* 41)

like a projectile fired with the same speed and direction from a gun.

The rocket rises vertically at first, and slowly, but travels ever faster (max. acceleration 6G) until about a minute later it reaches the cut-off value over 3,000 mph.—nearly five times the velocity of sound. The jet flame which helped to keep it in sight ceases and it is lost to view. It is terrifying to watch even from 1,000 ft. distance, because it soon appears to be directly overhead, and air currents disarrange the smoke generated at fuel cut-offs. You assume flight is erratic.

Seventeen triangulated checking stations are used in tracking V-2, with which four different tracking methods were used May 10: radar, optical, photo, and sonic (Doppler). The radar methods involve radar impulses from a unit in the nose and reflections from three tail surfaces. Both optical and photo (the latter for record) are achieved with an ingenious German instrument, the Askino theodolite, set up 8 to 10 mi. from the launching site. The unit has a tremendous lens, which enables two operators to watch the V-2 for 150 mi. *visually*. A built-in camera records the action at 60 frames per sec. Three of these instruments at widely separated points permit checking of roll of the projectile by showing the special pattern painted on it.

Newly developed radio beacons, which contain their own power supply and are actually miniature radio receiver-transmitters, have been fitted into the V-2 "peacehead" for one tracking device. Antenna are in plastic housings on fins. During flight, the receiver is triggered from a ground radar set by pulses which cause the transmitter to repeat the pulses to the radar. This permits the trajectory to be recorded photographically. The Signal Corps radar set used is modified from a unit developed during the war for detecting hostile aircraft and directing anti-aircraft guns.

Conventional radar equipment also tracks the V-2 for its entire flight without the aid of beacons. As the V-2, as fired on London, contained no electronics guiding equipment, emissions of which might be tracked, this method simulates detection of rockets fired by an enemy.

The V-2 is set for firing by an ingenious elevating boom, designed in Germany for that purpose. It is known as the *Meiller Wagon,* and is long enough to carry the V-2 with ease and set it into place by means of its self-contained, motor driven, hydraulic lifting system. It is equipped with platforms which swing into place, enabling workmen to climb up its built-in ladders to make final tests and adjustments after the rocket is in place for firing. It also carries feed lines for some fuels and stabilizes the V-2 until it is ready to fire. (Other rockets are placed by a 60-ft. high crane which operates on wide rails north of the launching platform. On this 1,000 ft. of track is also a rail launcher developed by the Germans for the V-2).

Also shown correspondents at the White Sands test was the "WAC Corporal," an all-American design rocket. The WAC Corporal is a liquid-propelled missile—unlike many solid-fuel types

developed at Calif. Institute of Technology in a program sponsored by the Ordnance Dept.

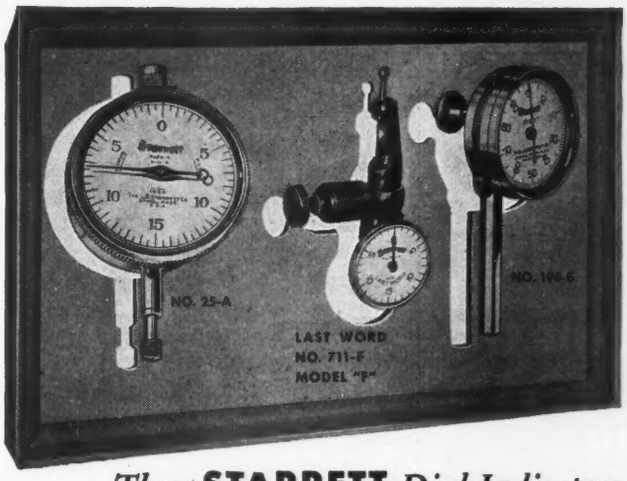
The Corporal differs from the V-2 in more than size—it's 1 ft. in diam., 16 ft. long and weighs 700 lb at launching—for it has no control system except three stabilizing fins.

It is launched vertically from a triangular 100-ft. launching tower, and thereafter goes its own merry way, affected by wind, earth rotation and its own peculiarities. These characteristics suggest some of the reasons for the female appellation of "WAC," the "Corporal" coming from the fact that some Army rocket projects are designated by familiar ranks. Suffice it to say, officers in charge of the May 10 test (all married men by the way) were so uncertain of its actions that they kept all observers at the very respectful distance of six mi. Indications were that it—or the two principal parts into which it breaks when its fuel tanks collapse as it reenters the atmosphere, fell into the desert five mi. the other way, but it appeared to be right over this reporter's shrinking scalp when it vanished on its way up.

The WAC also differs from the V-2 in having different chemicals to power pumps which feed propellants to the combustion chamber and in being "boosted" during its first few seconds of flight by a powerful, short-duration solid-fuel step rocket. This brings the WAC to supersonic speed in 0.6 sec., then falls away to let the WAC motor carry on alone. Judging by its actions and by the appellation "Tiny Tim" which officers let slip, this step rocket is a variant of the giant rocket which made a fighter plane able to hurl at an enemy target more high explosive than is carried in a salvo from a light cruiser. Tiny Tim was the first multiple-grain American rocket, having four dry-extruded ballistite grains, each weighing some 40 lb. Its original war head was 150 lb. of TNT.

Presumably, the launching tower could be tilted slightly to "aim" the WAC and payload limitations are believed to be sufficiently large to carry an atomic warhead, but primary present development is to make the WAC a vehicle to carry meteorological instruments into the stratosphere. In tests at White Sands last October, the WAC reached an altitude of 230,000 ft., or 43.5 mi. This elevation was assumed to have been attained in the May 10 test, although radar tracking failed at 55,000 ft. because the rocket was too small to track further by radar.

The WAC costs about $50,000 to make in this country. This could undoubtedly be cut considerably in mass production, but the WAC will probably be discarded in favor of models now



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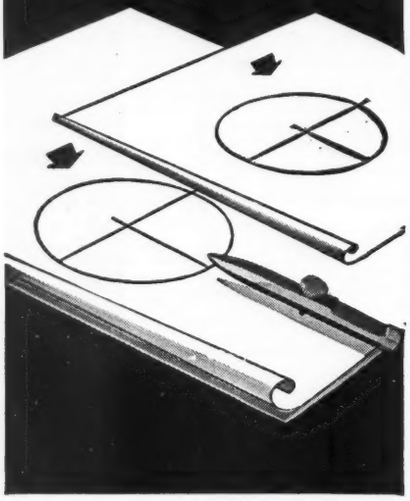

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under development. The WAC Sergeant (to anticipate a name as well as to conjecture about characteristics) will probably be thinner-shelled and generally lighter in details, hence able to match the V-2 in altitude and may also carry a higher payload. But officials developing it aren't talking.

Both the V-2 and the WAC will be used to carry instruments into the upper atmosphere in future tests. These will measure temperatures, densities and pressures, make spectographic records, count cosmic rays, take samples of gases, dust and bacteria (if these reach such heights).

Still other measurements are being suggested by scientists from all over the country, indicating that some will be disappointed or more and bigger rockets will be required. Officers conducting the tests also want to make some measurements of their own. Skin temperatures, action of control vanes on the V-2 and their effect where there is no atmosphere for them to act upon are among them.

It is known, for example, that the V-2 does not fall with its axis parallel to its trajectory, until it reenters the atmosphere. For some period after its propulsive power is expended and the earth's gravitational pull begins to pull it back, the V-2 remains in its final uptilted position. Control gyros may activate vanes, but nothing can happen until the vanes have some air against which to push. Then aerodynamic surfaces again become effective.

Skin temperature is estimated to rise to about 600 C. (1,300 F.) when atmospheric friction decelerates it from its top speed of 3,500 mph. to 2,600 mph. before it strikes. Enough of this heat is transmitted to the control chamber that plywood dividers there are scorched. This is of course a problem in instrumentation as well. Scientists thus have three choices:

1. To produce instruments which can stand the shock of striking the earth, the heat of deceleration, and possible explosion of remaining fuels.

2. To use instruments that broadcast to ground recording devices.

3. To devise instrument carriers that will throw them out after desired records are obtained, then parachute them safely to earth.

Of these three, the third appears most advisable, but presents several serious difficulties. What cover material will withstand ejection shock and frictional heat? How can speed be reduced safely, when a conventional parachute will not open where there is no air and would promptly burn anyhow when air friction is encountered at supersonic speed? The parachute could be forced open by an inflatable rim tube operated by a compressed-air bottle, but the heat problem remains. One solution might be to eject the instrument container backward with sufficient force to counteract enough of the rocket's forward speed so skin temperatures stay low. Another is to use metal vanes instead of a 'chute.

Incidentally, there have been frequent press reports of offers by individuals to ride within a V-2 at their own risk. These are true—I read one letter from a sane and responsible New England man of some prominence, who has developed a pressure suit. The V-2 could readily carry him, and the 6G maximum acceleration never approaches the 8 or 9G at which men "black out," so getting him up there would be simple. But how can he be ejected and decelerated without burning to a cinder? And if he stays within the rocket until close above the earth, how can he endure the inside temperature?

Meanwhile, the V-2 provides 20 channels for sending back radio and radar records of its flight. These will be used to examine to the greatest possible extent the outer reaches of the earth's envelope, where comsic rays and shooting stars abound, beyond the fringes of the atmosphere which acts as a filter for such visitors from interstellar space. Our present knowledge is limited to distances of only 19 mi. above the earth—the V-2 and the WAC-to-be may make it possible for us to reach out to 150 mi.—or eight times as far.

"Crossroads" Critique

(*Continued from page* 39)

the quick answer would be "Yes." But on sober second thought, the unfeasibility of this idea becomes obvious. We have no metropolis which we can write off in such disruption. It would be out of the question to build a test city just for that purpose. And the risk of "trying it" on slum areas "which ought to be cleaned out anyhow" is unthinkable, considering the menace to the surrounding community area.

Another point is that Britain has the only other major sea arm, so what meaning can there be in naval-offensive lessons learned at Bikini, considering the very specific unliklihood of our warring with England? This time, the premise is readily resolved: We intend to benefit by *defensive* lessons. True, it could now be reiterated how an enemy would, instead, lay assault to our cities. But there is at least this rationalization: From the elementary viewpoint, we wish a test—broadly speaking—against a representative grouping of man-made structures and equipment. With a city target unacceptable at this time, the naval vessels afford us a fitting alternative.

Let us now consider the precise investigations planned at Bikini—and let us say here that these definitely are not slipshod, too hastily arranged, or uncomprehensive, as some tend to argue. Six months have been expended in the setup alone. In all, there are nine primary technical-staff divisions. Besides (1) the handling of the bomb operation, there are studies of (2) blast, pressure, and shock; (3) wave motion and oceanography; (4) electromagnetic propagation and electronics; (5) radiological safety; (6) radiometry; (7) radiation; also (8) remote measurements; and (9) technical photography.

As for aircraft, they will: (1) Drop the bomb; (2) gather all possible scientific data by means of instruments, photos, and air samples; (3) provide for any necessary air-sea rescues; and (4) afford accommodations for test directors, for scientific observers, and also for press and radio men.

Five B-29 bombing crews have been designated to stand ready, and these are continuing to practice the pattern. At the last minute, one of these teams will "get the nod." This selected crew will initially make three "dry" runs, then plummet the A-bomb on the fourth—or a later run if there is any hitch. An inordinate number of "refusals" will bring postponement of the test to another day. Weather experts have calculated that the Bikini area has seven or eight days in each month which are suitable for Blast Four. East winds would be required up to 30,000 ft. to keep the atomic cloud from jeopardizing the supporting fleet and adjacent islands. Then, too, the weather must be clear enough for bombardier to see the target.

Further notes: In pre-tests, some 30 "pumpkins"—atomic bomb dummies—have been loosed, both on rehearsal targets off the West Coast and, presumably, at Almagordo, and about the same number of sham bombs are being triggered in early trials at Bikini. . . . Expense of the Bikini project has been exaggerated, for 90% of the target ships have been earmarked for scrap. The cost of personnel, instrumentation, the bomb, etc., brings the sum to the neighborhood of the outlay for one modern warship, and this is considered cheap. . . . Exact dimensions of the target pattern is not divulged, but it is known that some 23 vessels will be within a thousand yards of the blast. . . . One report has it that twenty scale-model tests were made, simulating Operation Crossroads with 3¾-lb. charges of TNT detonated over 2-ft. models of Victory ships floating in deep water. Reported results: Hatches were disrupted, plates were buckled, the ships were violently gyrated, but none sank. . . . The Bikini test will be run on code-time. X is hour of arrival at test stations. H is predicted hour of blast, M is hour of actual blast, and M-Plus will denote times of all succeeding studies of air, water, and atoll soil; tracing of the bomb cloud; reading of various instruments; entry into blast zones; and the like. . . . Many of the scientific answers supplied by the test will be available immediately; however, some won't be known for months, others not for years or even in the lifetime of the men concerned.

It has been announced that there will be no overall censorship in relation to Operation Crossroads, but there are these seven specific taboos: (1) Precise horizontal distance of the bomb burst in relation to the target array; (2) exact altitude of explosion; (3) exact bearings of the target vessels in relation to each other and to the pattern; (4) all techniques and equipment in relation to carriage and release of the bomb; (5) exact data concerning pressures, temperatures, and the various other pertinent studies, (6) the degree of efficiency of the bomb itself; and (7) any photos or information which, in themselves or in combine with others, would lead to conclusions on the other six points.

Among phenomena to be checked are effects of explosion on aircraft in flight (the drones), effect on radio waves, and on radar, also blast pressure, infra-red rays, photography, and radio activity in the air. And among other measurable elements are heat radiation, light, gamma rays, water waves, shock waves in air and water, and motions of aircraft and of ships as a result of the bomb burst. The following outline supplies further details on the studies:

Instrumentation required to measure air blast, under water pressures, and shock wave velocity, will be primarily concerned with pressure and shock in free air and water (independent of ship structures) as functions of distance and time. Most numerous instruments are ball crusher gages and aluminum foil meters, the former measuring air pressure by the deformation of a soft copper ball by a steel piston in a narrow cylinder, and the latter calculating air pressure by the rupture of aluminum foil. Other instruments will measure underwater pressure time curves, peak pressures, and shock wave velocity.

Ship instrumentation will be concerned with the observing and measuring effects of the blast causing structure damage to the various target vessels and their machinery and equipment. Strain and displacement gages, of many types, will comprise a mechanical linkage system connecting two portions of the ship's structure and equipped with indicating means. A simple device for the measurement of blast effects on the deck of target ships will be empty 5-gal. gasoline cans, blast pressure being determined

HANGAR FLYING

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The Wreckers

If you ever want to tear a wing off an airplane, check with the men in the Structures Lab at Lockheed's Factory B-1 in Burbank. These boys are experts.

Not long ago their entire career consisted of deliberately ruining the meticulously engineered assemblies that went into the *Constellation*, just to see if the parts came up to Lockheed's exacting standards.

For instance: they took up number 61 (the first *Constellation*), blew a hole in one of the two tires on the nose landing gear, and then brought the plane in at 80 mph. The *Constellation* landed nicely.

Another time these testers purposely threw dirt and water into the oil lines of the hydraulic booster system, forcing it to work under what they understate as "adverse conditions." Adverse, that is.

They even kicked around a whole tail control assembly in a chamber that was 70 degrees below zero (Fahrenheit) until all the low-temperature bugs had been licked.

As a result of this kind of highly creative destruction, which goes on at Lockheed year in and year out, the *Constellation* is the most advanced and safest transport in service today.

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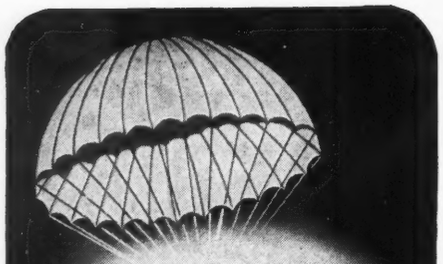

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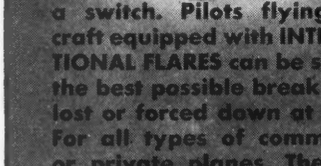

1-minute Flare

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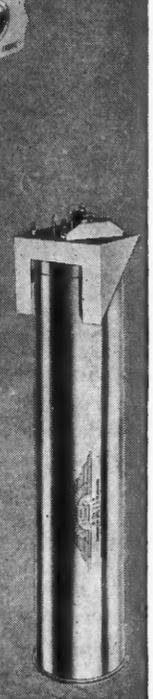

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For planes of any weight, scheduled or unscheduled operations. Sealed all-metal case assures longer effective service life. May be installed in wings or fuselage. Exceeds 200,000 candlepower.

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by the amount of crushing of these cans.

Navy drone aircraft which will fly in the proximity of the blast will be equipped with VGTA (velocity, gravity, time, and altitude) recorders, while AAF drone aircraft will carry television transmitters, recorders, and flight analyzers, all devices to report and record the effect of the detonation wave on the operating characteristics of aircraft. No aircraft which carries personnel will approach nearer than 8 nautical miles to the blast, and it is expected that the bomb-carrying B-29 will have retreated to such a distance after its drop and prior to the detonation. Drone craft, of course, will go directly into the burst-cloud.

In the field of wave motion, supersonic echo sounders will measure the vertical motion of both the target ships and buoys, while pressure recorders on the lagoon bottom will record water depth versus time by measurement of the hydraulic pressure. There will also be extensive aerial and surface photography of the water waves and motion of the target ships under wave action. In addition, seismographs will be set up on the islands to observe the propagation of the shock waves through the earth.

Measurements also include extensive surveys of the atoll and the surrounding regions with regard to effect on physical oceanography, also biology, geology, and fish.

In the sphere of electromagnetic propagation and electronics, studies will be made of the A-bomb effects on the propagation of electromagnetic waves. These tests are planned to show the influence on both ground and sky wave transmission of the intense local ionization resulting from the detonation. Other experiments will show the radar reflective properties of the bomb cloud and the intensity of the atmospheric electrical disturbances developed by the explosion.

Standard radar and sferics (direction finding) equipment, also devices specially constructed for the tests, will be used to measure the electromagnetic propagation. AAF drones will carry Geiger counter warning-circuits and transmitters to determine the effect of the bomb explosion on radio propagation in the 5-9 mc. range.

Section on safety involves safeguarding of personnel with respect to radiological hazards to be encountered. This includes measurement of radiological phenomena in areas to be entered by various personnel and for tracking movements of radioactive air and water masses. Primary safety device is the portable Geiger counter, which indicates radioactivity by a clicking sound or the movement of a hand on a dial. The counter consists of two electrodes in a gaseous medium. Passage of an ionizing ray through the counter permits a small current to flow across the electrodes. This current is a measure of the intensity of radiation. Additional safety devices are ionization chambers, specially sensitized films, and chemical capsules which indicate total radioactivity from the measurement of induced radioactivity.

Radiometry concerns measurement of light in the visible spectrum and the adjacent wave bands, such as ultra-violet and infra-red. This is distinguished from calculation of radiation or the measurement of gamma rays, neutrons, etc. Among instruments used here are: Spectographs to obtain spectral distribution of the first flash; photoelectric units to reveal intensity of the first flash as a function of time; and bolometers to measure total radiant energy emitted by the first flash.

As for radiation, findings in this field will not be published, in accordance with current security restrictions. Instruments and techniques used here are also "classified."

Remote measurements will deal with determination of tidal data at Midway, Wake, Kwajalein, and Eniwetok. In addition, shock will be gaged at these islands, and radioactivity will be traced in the whole central Pacific area.

Operation Crossroads will have a technical photography section that involves hundreds of cameras of a wide range of types. Ground and aerial photographs will be made before, during, and after the drops. In addition, motion picture and still cameras will record background material for a complete pictorial record of all phases of the experiment preparations.

Ground photos will be made from fixed installations on 75-ft. steel towers, placed at strategic points on Bikini Atoll. All these cameras will be radio controlled.

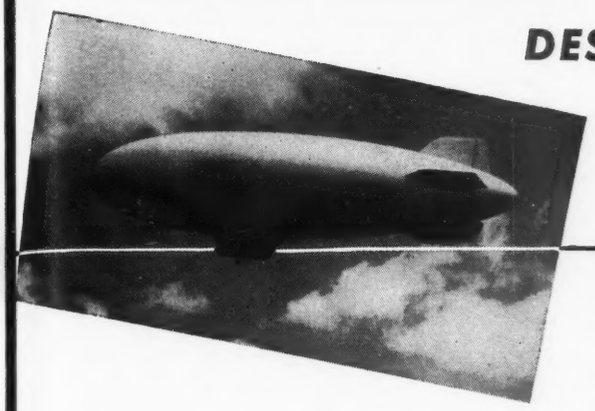
In the target pattern, Orbit Points and Reference Points have been set at varying degrees and nautical miles from aiming point, and these will be used to key the precise missions of the aircraft. Here is the complete check of the aeronautical operations:

The B-29 command plane, flying at 8,000 ft., will rove approximately 20 nautical miles from the burst. And the B-29 bomb carrier will fly on an axis of 45 deg. toward the target and, at the time of the blast, will have turned to left (approximately 150 deg.) and be headed out from the target.

Two B-29s, operating slightly below bomb carrier and flying in a circle 180 deg. apart, some 10 nautical miles from target, will drop pressure-measuring instruments. Of eight F-13s, four will circle at 26,000 ft., 90 deg. apart, at some 15 mi. distance; other four will be a little higher than bomb plane, with one

To attain maximum strength and lightness

DESIGNERS TOOK A TIP FROM MOTHER NATURE



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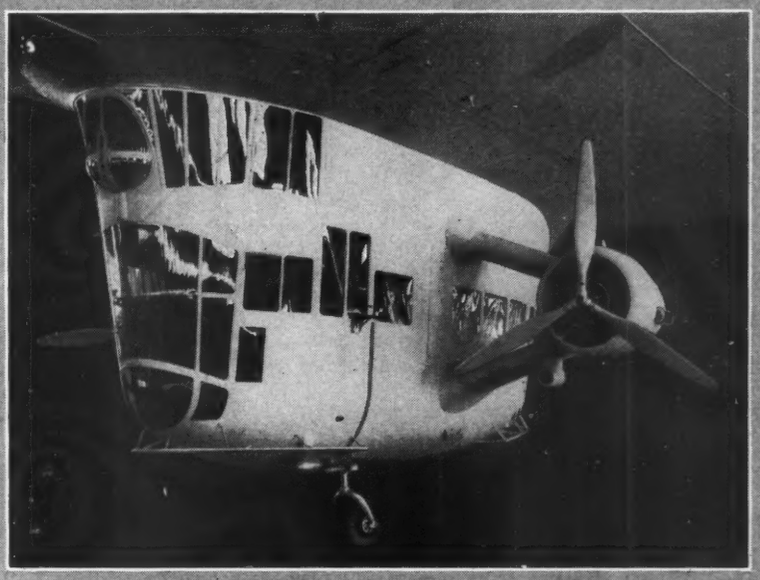
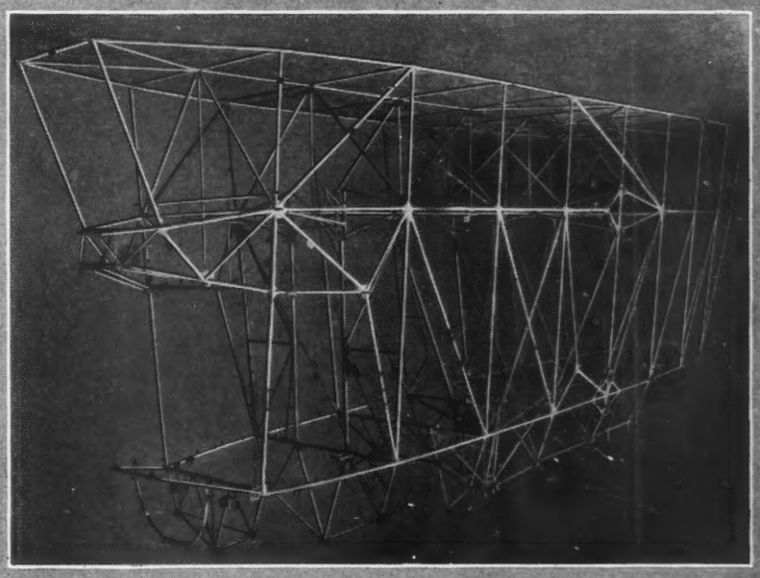
Used in the transverse frames, diagonal bracing and connecting longeron, SHELBY Tubing of chrome molybdenum steel keeps weight to the very minimum yet insures the utmost in ruggedness and shock-absorbing qualities. And because in lighter-than-air ships like this, every ounce of weight must justify itself, SHELBY Aircraft Tubing is also used to obtain highest strength-weight ratio in the outrigger frames that support the engine mounts.

In every type of aircraft, SHELBY Seamless Aircraft Tubing provides structural superiority. In jet planes, SHELBY Tubing maintains strength at extremely high temperatures. In flying freighters and heavy passenger transports, SHELBY Seamless Tubes provide extra stamina to safely absorb the tremendous shocks of landing. In helicopters and sport planes that must be light, strong and safe, SHELBY Tubing fills the bill at lowest cost.

No other structural material is more versatile than this superior steel tubing. You can bend it. Weld it. Shape it into almost any form required. It is easy to machine. As a safeguard to uniform quality, all U·S·S SHELBY Seamless Aircraft Tubing is made to exacting government specifications. It is available in a complete range of sizes and shapes and in the current alloy steels. Our engineers will gladly cooperate with you in its most efficient application.



GUARDIAN OF THE CONVOYS, watchdog of the coastal patrol, the Goodyear Model K Airship has merited this tribute from the Navy:—"Not one of the thousands of transports and supply vessels escorted by the Navy's non-rigid (Model K) Airships has been lost in submarine attack."



HERE'S THE COMPLETE car framework assembly, 42½ ft. over-all at the top and 14 ft. high, of SHELBY Tubing throughout. Note the additional bracing at landing wheel (center bottom) to absorb the impact of wheel loads. The chrome molybdenum steel used insures high strength and high resistance to fatigue, vibration and shock.

U·S·S SHELBY SEAMLESS *Aircraft Tubing*

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Tubing Specialties Division

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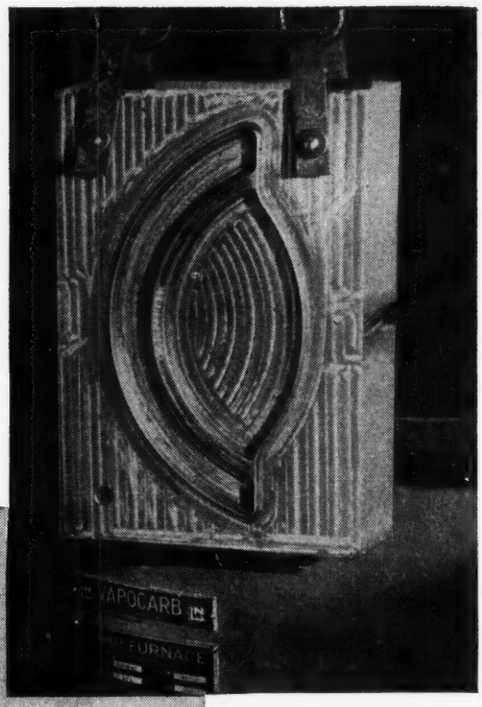
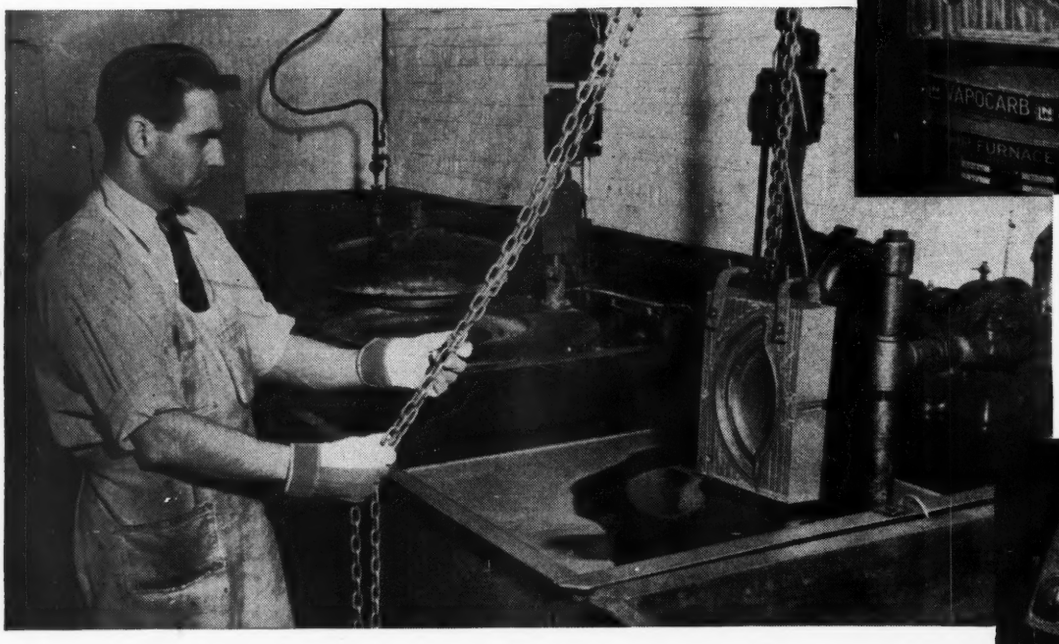
UNITED STATES STEEL

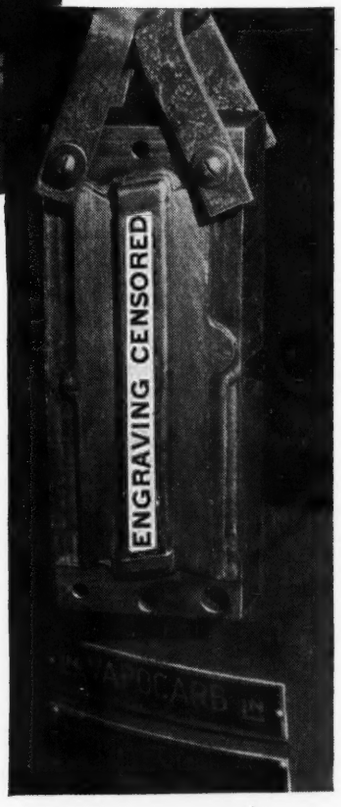
TOOLING UP?

Punches and Dies should Last Longer if they are Vapocarb-Hump Hardened





Croname Inc. gets "perfect" heat-treating results when expensively-engraved tools like these are Vapocarb-Hump hardened



Three considerations have led Croname Inc., Chicago specialists in fine metal craft, to use the Vapocarb-Hump method for hardening the big dies required for their customers' work.

1. Experience. Most methods of hardening and most tricks of the trade have been known and used by Croname, and Vapocarb-Hump hardening has been selected as a result of this experience. The Vapocarb-Hump method protects the engraved surfaces against both scale and decarburization; it automatically maintains temperature with great accuracy; it records the temperature of the die itself; it records (and can control) the difference between temperature of die and that of furnace wall. With all these features at his command, the heat-treater is able to harden both hobs and dies for longest life and greatest production.

2. Investment. These big tools represent much toolmakers' time and up to several hundred pounds of fine tool steel. Croname protects this investment by Vapocarb-Hump hardening.

3. Customer-pleasing. When it takes several weeks to make the dies for an order, the schedule obviously won't stretch to accomodate extra toolmaking. Croname has found that Vapocarb-Hump Hardening helps the heat-treater to do every job right, and on time.

If you have a tool heat-treating problem, an L&N engineer will gladly call to talk it over, or will send a Vapocarb-Hump Catalog, as you prefer.

LEEDS & NORTHRUP COMPANY, 4906 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad T-621(35)

following about 4 mi. behind and to left of bomber and turning away at same time. Other three head toward blast from 20 mi. out, taking their photos.

Of four Boeing B-17 drones, four B-17 control planes, and one B-17 master control craft, one drone will be ready at 24,000 ft., will enter blast cloud, then be picked up by its control plane, which flies around blast clockwise—or by master craft if control doesn't get there in time; and other three drones, at 30,000, 18,000, and 13,000 ft., respectively, will weave similarly through cloud for 30 min. Master plane will stand by to aid in control, i.e., 5 mi. away at 24,000 ft.

Of two Douglas C-54 photo planes, one will take up circle flight at 15 mi. distance, then after shock wave will close in to 8 mi. Second will operate from a point 7 mi. distant. B-29 press photo plane, at 4,000 ft., will circle 20 mi. from explosion, and B-29 broadcast plane will be at 8,000 ft., likewise at 20 mi. Two other C-54s, carrying official observers, will also fly at the latter altitude and distance. Operating at 25,000 ft., two B-29s and two F-13s will track the movement of the blast cloud over the sea to determine its persistency and radiological activity.

Of the four Navy F6F drones, each will be guided by two 2-plane sets of control craft (16 control planes). Initially stationed at 28,000, 20,000, 15,000, and 10,000 ft., respectively, drones will operate through blast cloud in sequence, one control "pitching," other "catching."

There will be three Martin PBMs for emergency air-sea rescue, two at 3,000 ft., third at 7,000. Four F6F photo planes will fly over atoll for vertical "shots" 30 min. before blast. Two TBM Grumman Avengers will circle at 9,000 and 4,000 ft., 15 mi. off, to get flashes. Four TBMs will control boat drones which, about 1 hr. after burst, will go into lagoon to test safety of entry. There will also be two HOSs (R-4 Sikorsky Army helicopters). One is slated to pick up dirt samples at Bikini, while other will be stand-by.

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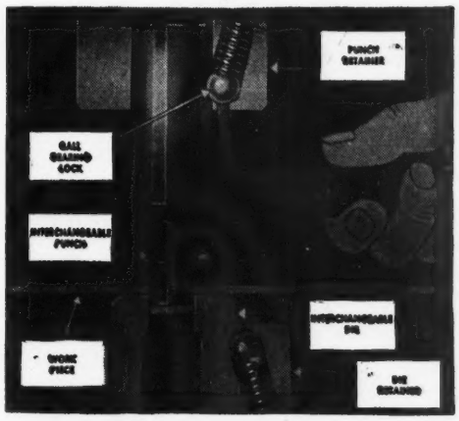
The Original



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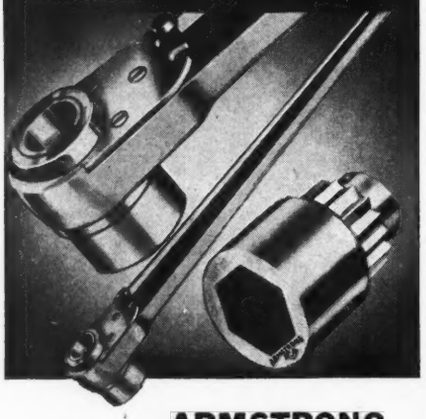

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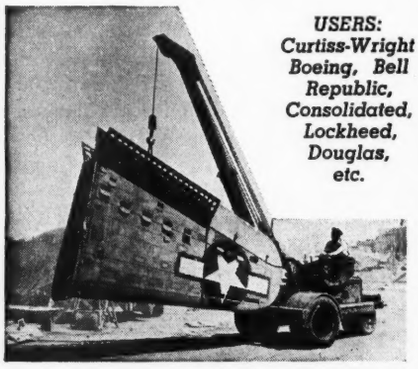

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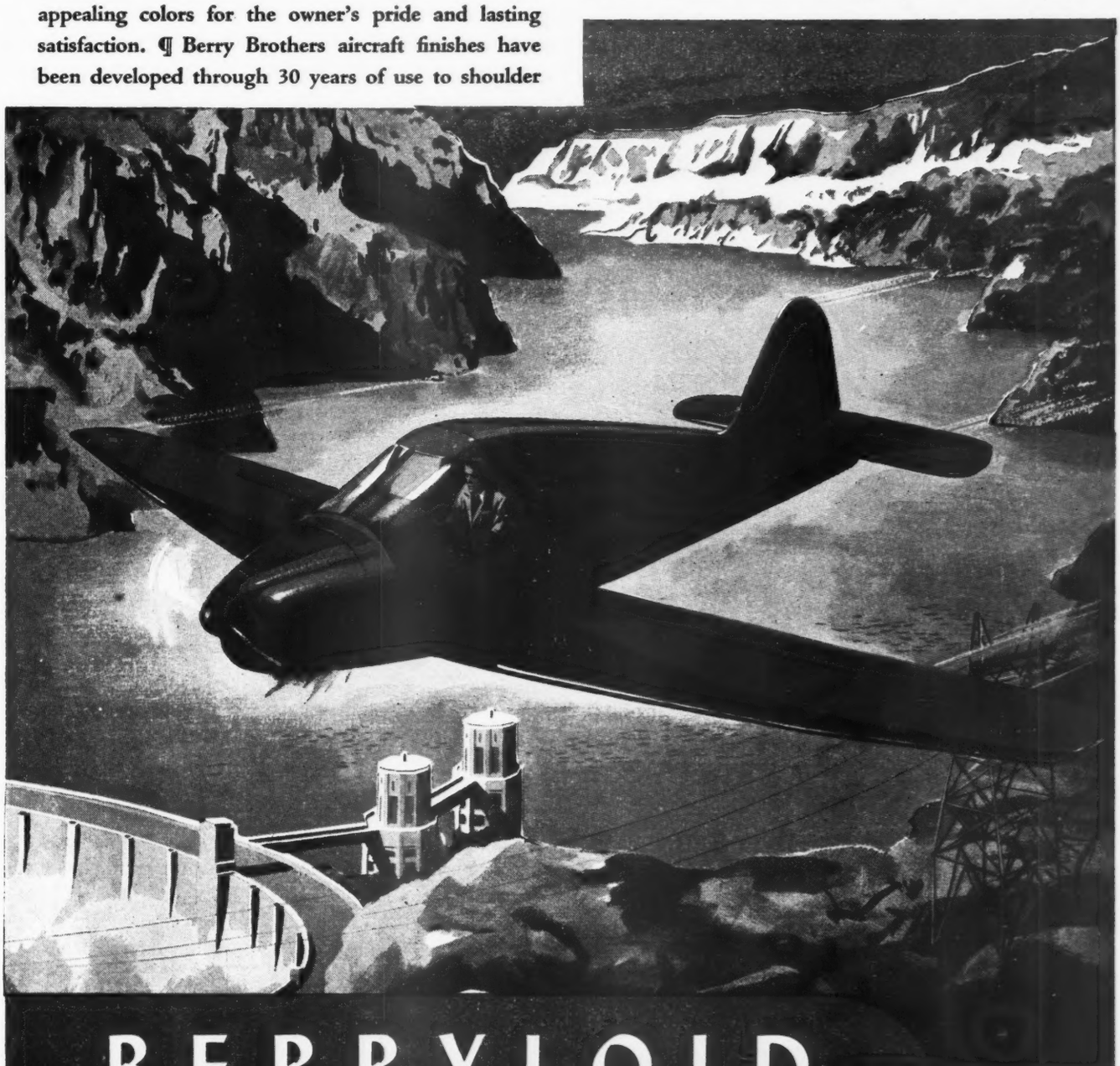

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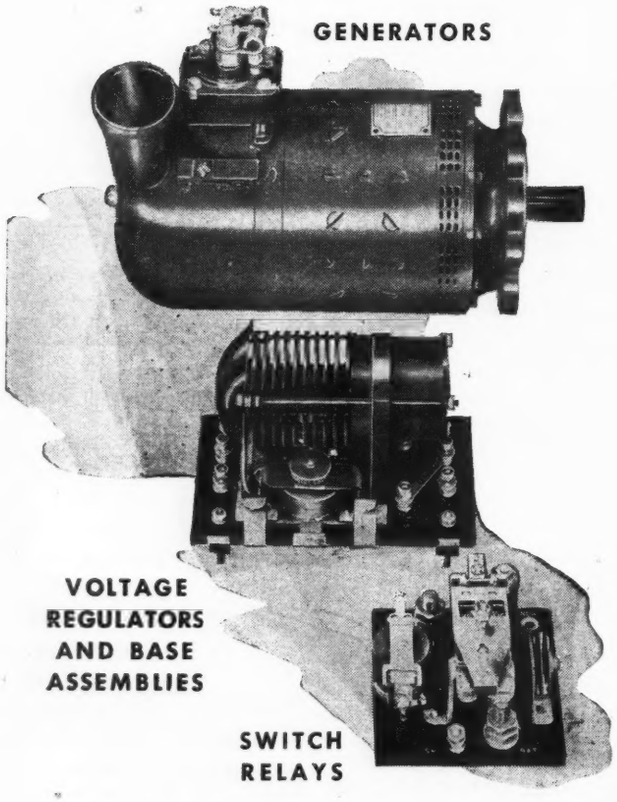

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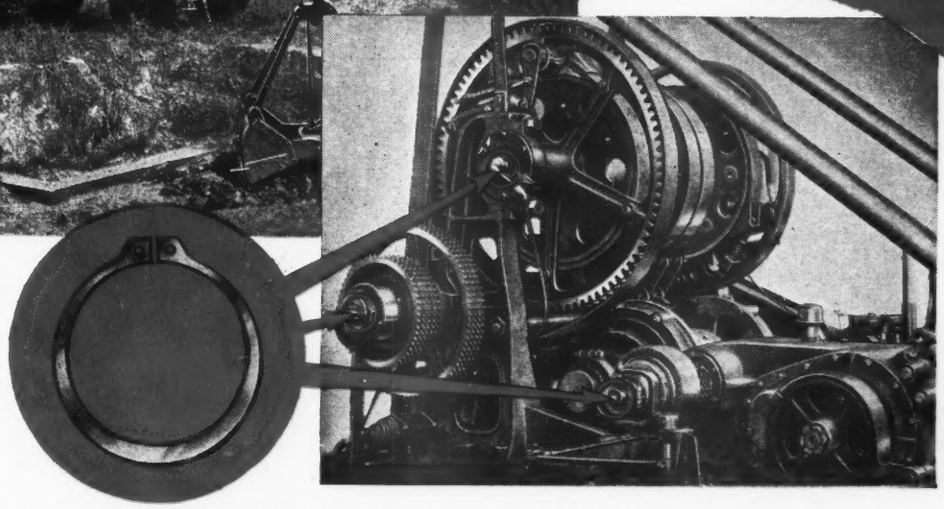

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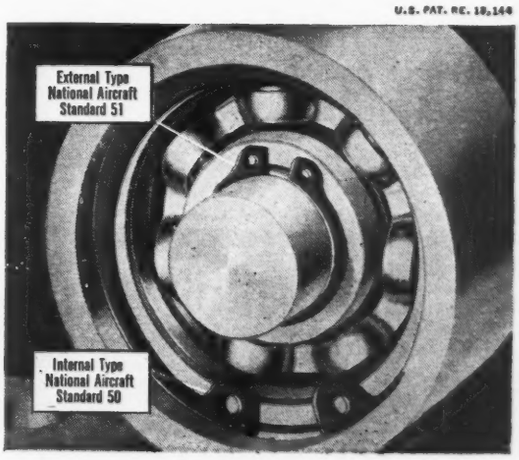

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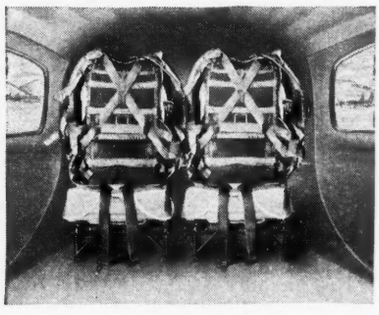

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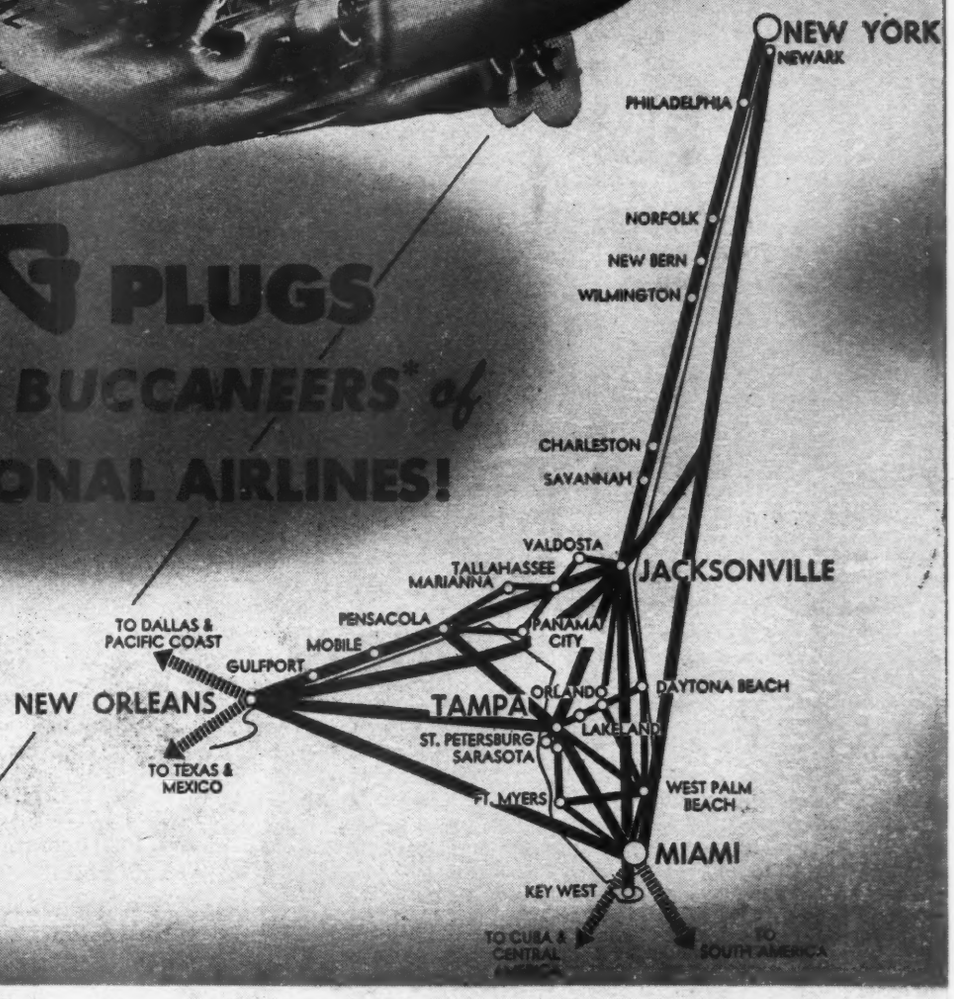

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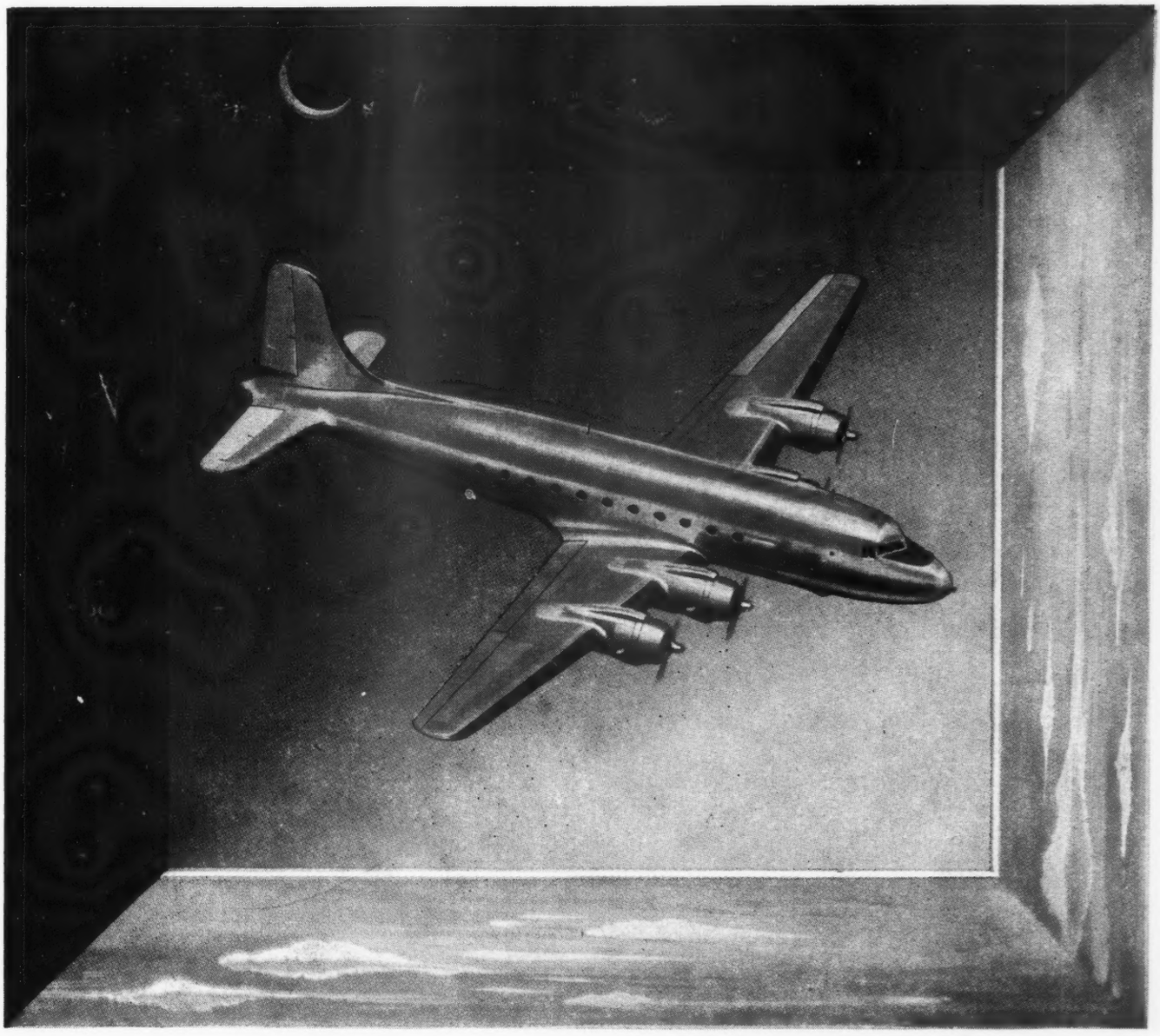

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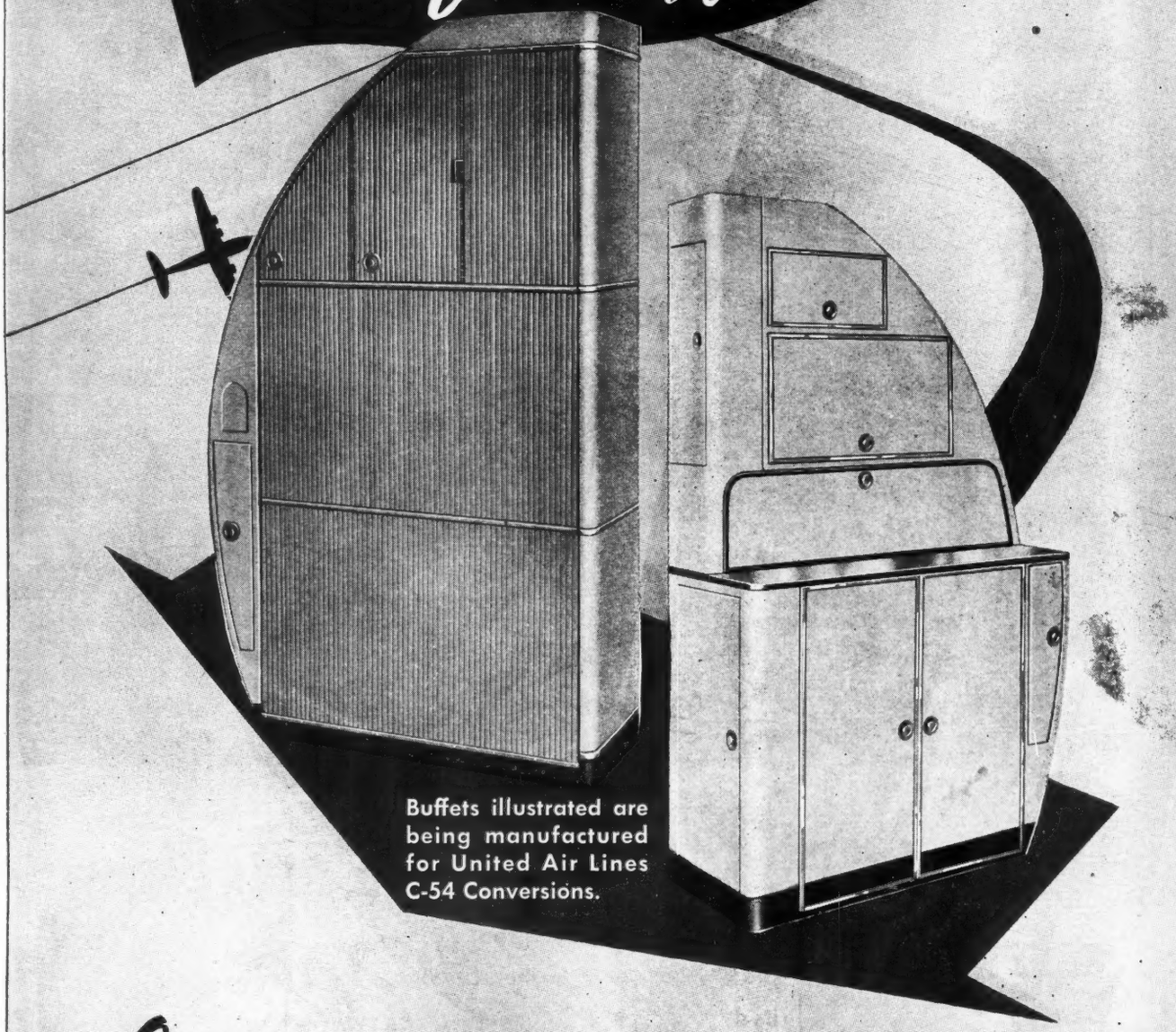

Buffets illustrated are being manufactured for United Air Lines C-54 Conversions.

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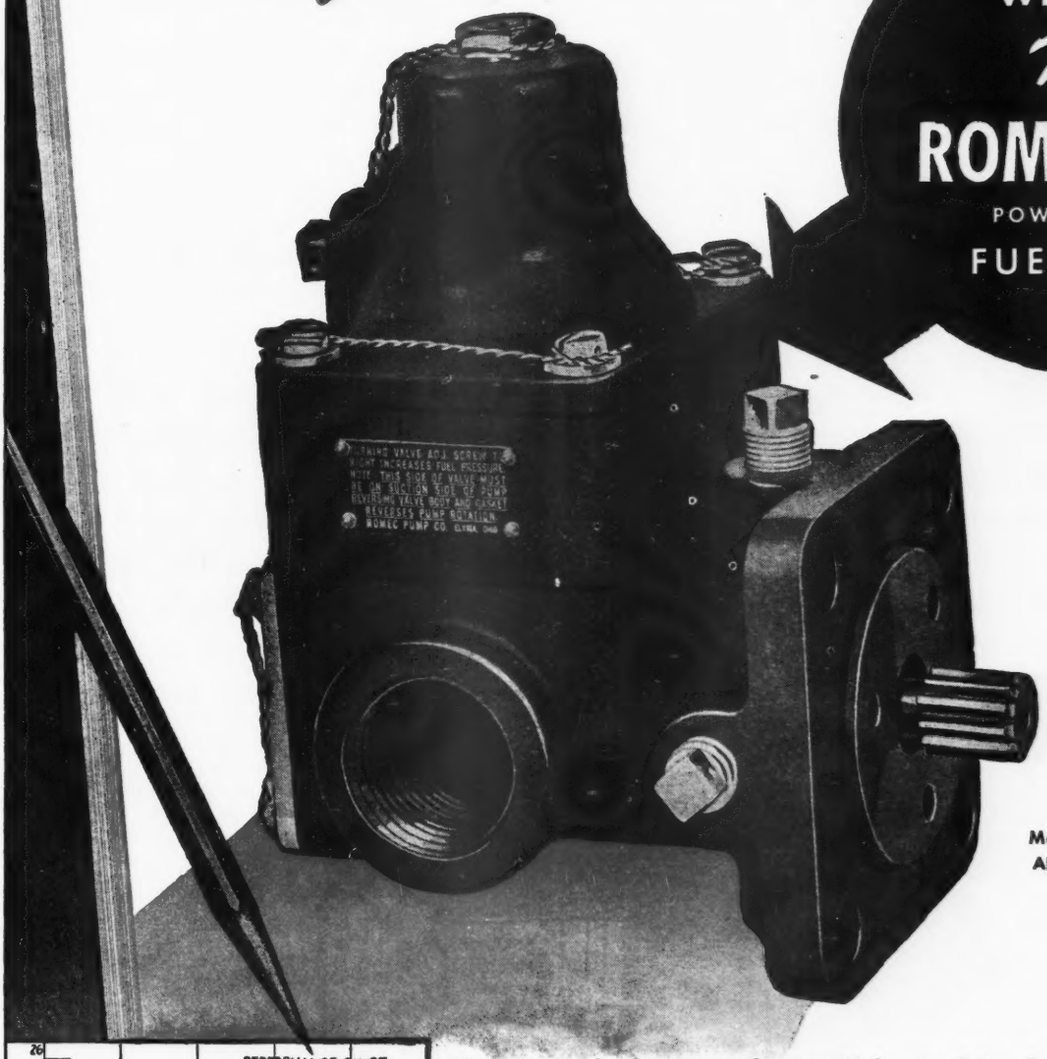
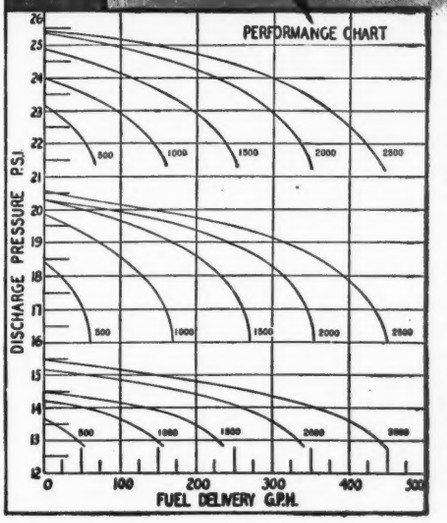


Meets AN-P-52 and AN-P-56 Specifications



Here is a fuel pump that will be in big demand for postwar planes. With its higher pressure range of from 6 to 35 lbs., its 400 gallon per hour capacity at 2500 rpm., and its low weight of only 2¾ lbs.—It's a winner.

Built with a balanced type relief valve with shaft seals that are dependable through extreme temperature ranges. This pump is now in production. In writing, kindly refer to type G-9.

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NON-PULSATING PUMPS... ACCESSORIES

Tri-Sure LEADERSHIP

is your protection

Tri-Sure Drum Closures are used in more countries, by more companies and for more products than any other closure—proof of their acceptance as the best protection for liquids shipped in drums

Tri-Sure Closures have the endorsement of more experienced shippers than any other device ever developed for protecting liquids in metal drums and pails. The reason is that Tri-Sure Closures have demonstrated all over the world, under every condition, that they are the most completely *reliable* safeguard against leakage, seepage, pilferage and substitution. Tri-Sure *leadership* is your *protection*—your assurance that you are using the closure that is rated No. 1 in soundness of engineering and efficiency of performance. Get this protection in every shipment, by specifying "Tri-Sure Closures" in every drum order.

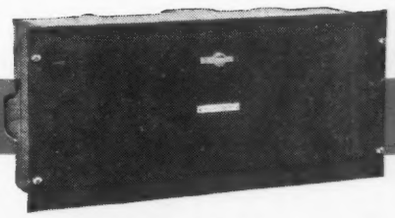
Tri-Sure
$100.00
will be paid by the AMERICAN FLANGE & MANUFACTURING CO. INC., to anyone in the U. S. A. or Canada causing arrest and conviction of persons unlawfully removing genuine Tri-Sure closures and seals, with intention of committing a felony. Suitable reward will be paid in other countries.
Guaranty

Particulars on Request

Tri-Sure
Reg. U. S. Pat. Off.
CLOSURES

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

The Collins 51N-1 Receiver



. . . Designed by a Famous Airline

Now available to all!

The 51N-1 is a new single channel ground station receiver, designed in the communication laboratories of United Air Lines. Through special arrangement, the Collins Radio Company is manufacturing this receiver, for all commercial applications.

Reflecting the wide experience of United Air Lines, the 51N-1 is thoroughly and specifically engineered for airline reception and monitoring on any one channel between 2.5—12.0 mc.

Crystal control provides a very high order of stability. The performance characteristics exceed the requirements of airline radio reception. Simplex operation may be used for control purposes. Noise limiter, carrier control, b.f.o., and other special features are available on order

For complete information, write to Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

SPECIFICATIONS:

Application: single frequency reception

Frequency range: 2.5—12.0 mc

Frequency control: quartz crystal

Signal to noise ratio: 10 db at 2 microvolts input across 100 ohms

Sensitivity: variable manually

Image rejection: 85 db minimum

Selectivity: 5 kc total bandwidth at 6 db down from resonant frequency; 16 kc at 60 db down

Weight: 29 pounds

Dimensions: standard 19″ rack mounting panel, 8¾″ h, 11″ d

IN RADIO COMMUNICATIONS, IT'S . . .

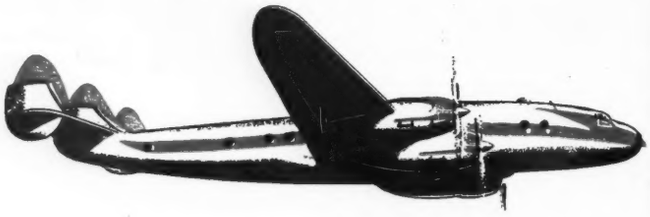
COLLINS

Super-Positives

BEFORE the war
DURING the war
and
TODAY...

The superlative qualities of U.S. *Super-Positive* Piston Rings give dependable support to America's air supremacy...with

Positive Performance . . . Durability . . . Economy



Another proof of the fast pace of America's global flying—The Constellation—New York to Lisbon—9 hours 58 minutes—3,425 miles at 344 mph . . . fine example of

Positive Performance . . . Durability . . . Economy

US super-positive

Always Specify U.S. Super-Positive Piston Rings

U. S. HAMMERED PISTON RING CO., INC.
STIRLING, NEW JERSEY, U. S. A.

When Electrical Contacts MUST NOT FAIL...

Photo courtesy Kellogg Switchboard and Supply Company

The Choice of Experience is
KESTER ROSIN CORE SOLDER

Two generations of holding tight in the thousands of jobs industry has called on them to do . . . they've helped fight two world wars . . . prove Kester Cored Solders are ready for the big production job ahead.

Kester Rosin-Core Solder—the result of 47 years specialized experience—is virtually mistake-proof in application. The flux, right in the core, is scientifically balanced with superior alloys to assure a quick, simple, smooth job in one application. The solder bond is clean, tight and highly resistant to deterioration due to bending or contraction and expansion from temperature extremes. The rosin-flux will not harm insulation nor cause corrosion.

Equally outstanding for general work is Kester Acid-Core Solder. Both are available in a wide range of strand and core sizes, flux and alloy combinations. Kester engineers will gladly cooperate with you in the selection of a Kester Cored Solder custom made to solve any special soldering problem you may have. Write fully. No obligation, of course.

KESTER SOLDER COMPANY
4206 Wrightwood Ave., Chicago 39, Illinois
Eastern Plant: Newark, N. J.
Canadian Plant: Brantford, Ont.

KESTER
Cored Solders
FOR EVERY AUTOMOTIVE USE

INSURING A *Smooth Landing* AT 80 MPH

– *with the Red Elastic Collar that protects permanently against Thread Damage*

Again, in the huge Lockheed Constellation, ESNA Elastic Stop Nuts have provided the protection that has made them symbols of security to all aviation engineers. Every bolted connection on the tricycle landing gear, which must make smooth contact with the ground at 80 mph, has been made safe with ESNA Elastic Stop Nuts to help bring the giant ship in for a "feather light" landing. The full thread contact they provide absorbs the shock and prevents metal fatigue.

ESNA Elastic Stop Nuts are self-locking, easily removable, and reusable over and over. They protect permanently against Vibration, Corrosion, Thread Damage, Liquid Seepage and Costly Maintenance.

If fastening problems slow up your production or increase your maintenance costs, let us place the results of our experience and research at your disposal. Address: Elastic Stop Nut Corporation of America, Union, N. J. Representatives and Agents in many principal cities.

ESNA
TRADE MARK

The RED ELASTIC COLLAR

—denoting an ESNA product—

. . . is threadless and permanently elastic. Every bolt — *regardless of commercial tolerances* — impresses (does not cut) its full thread contact in the Red Elastic Collar to fully grip the bolt threads. In addition, this threading action properly seats the metal threads — and eliminates all axial play between bolt and nut threads.

As a result, the Red Elastic Collar acts as a shock absorber. It dampens impact stresses—and materially reduces the shock against the metal threads that causes thread failure in conventional fasteners.

ELASTIC STOP NUTS

INTERNAL WRENCHING

ANCHOR

INSTRUMENT MOUNTING

SPLINE

CLINCH

GANG CHANNEL

CAP

PRODUCTS OF: **ELASTIC STOP NUT CORPORATION OF AMERICA**

For EVERY point where fire may start...

PORTABLE EXTINGUISHERS for small blazes in cabins and auxiliary equipment
SMOKE DETECTION for baggage compartments (portables or systems for extinguishing)
BUILT-IN EXTINGUISHING SYSTEMS FOR ENGINE FIRES

—Kidde provides protection!

Engines? Kidde carbon dioxide systems put flames out in a hurry.

Cabins? Auxiliary equipment? Kidde portable extinguishers . . . light-weight . . . trigger-operated . . . smother incipient fires before they can grow.

Baggage and cargo compartments? Kidde smoke detectors flash a warning signal. Kidde systems or portables snuff out the blaze.

It's *Kidde*, nose to tail, on most of America's famous transports. Airlines and plane manufacturers interested in this *overall* fire protection are invited to discuss their problems with Kidde.

Walter Kidde & Company, Inc.
618 Main Street, Belleville 9, N. J.

Kidde

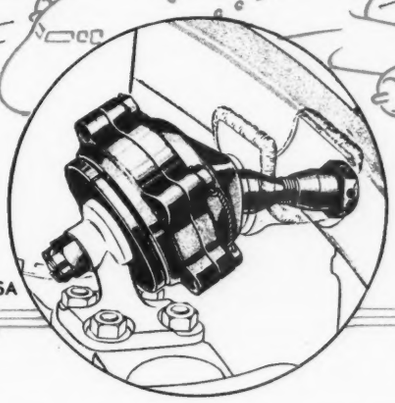
The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Kidde

FOR RECONDITIONING YOUR DC-3's and DC-4's

REPLACE with Genuine

LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS



MR-26-SA

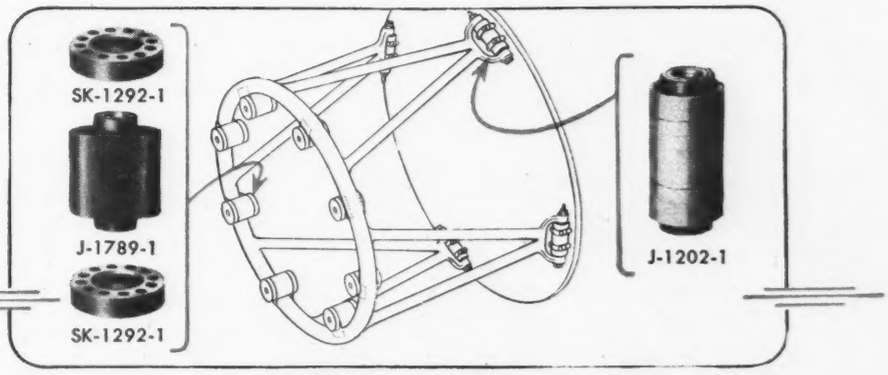
for DC-4's
LORD DYNAFOCAL ENGINE MOUNTING MR-26

LORD has foreseen the great reconditioning program which is under way, in connection with the reconversion of military aircraft for commercial use. We are prepared to make prompt deliveries of Lord mountings for use on commercial aircraft.

Lord has designed and manufactures mountings to flexibly support engines, cowling, instruments, and the diverse auxiliary equipment on practically every commercial and military plane produced in this country.

For your requirements of vibration mountings for aircraft, write to Lord—Vibration Control Headquarters.

for DC-3's
LORD
Insert, Sandwich, and Tube Form
MOUNTINGS



IT TAKES **BONDED RUBBER** *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
DETROIT - - 7310 WOODWARD AVE.
BURBANK, CAL. - 245 E. OLIVE AVE.
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

Every genuine Lord Mounting carries the name "LORD" embossed in the rubber or in raised letters on the forgings.

Originators of Shear Type Bonded Rubber Mountings

BONNEY "Preferred" OPEN-END WRENCHES

● Bonney Open-end Wrenches, like all the tools in the complete Bonney line, are *preferred* by mechanics who take pride in their tools. Bonney Open-ends are preferred because of their better balance, their pear-shaped heads with accurately milled openings and their greater strength and longer wearing qualities. Like all Bonney Tools, they are heavily chrome plated. They are tools every mechanic is proud to own. Ask your nearby Bonney Jobber or Distributor about them—or write for a copy of the Bonney Tool Catalog.

BONNEY FORGE & TOOL WORKS
711 N. MEADOW STREET, ALLENTOWN, PA.
In Canada: Gray-Bonney Tool Company, Ltd.
St. Clarens & Royce Aves., Toronto

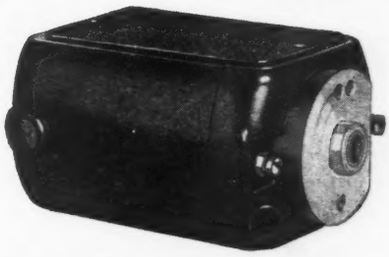
What QUALITIES do you want in Your New Products? a Lamb Electric MOTOR will help provide . . .

Good Performance • Dependability • Light Weight • Compactness • Appearance Appeal • Value Appeal • Low Maintenance

Probably no part of a motor-driven product has more influence on the design and operation features than the motor itself. That is why, in planning for the sharp sales competition that is ahead, more and more well-known manufacturers are turning to Lamb Electric motors.

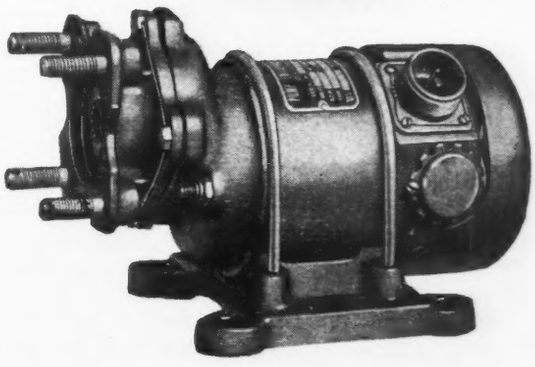
Our 31 years' experience designing and building small motors may prove valuable to your engineering department.

THE LAMB ELECTRIC COMPANY
KENT, OHIO



A compact motor, particularly suitable for computing machines and other types of motor-driven office equipment.

Space factor in this power unit is minimized by having output shaft at right angles to motor shaft.

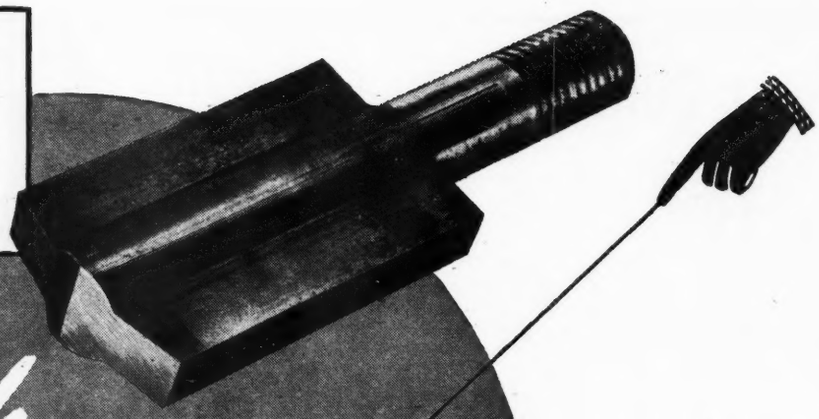


Typical applications for this motor: industrial vacuum cleaners, agitators, sirens and colloid mills.

Base-mounted, explosion-proof aircraft geared fuel transfer pump motor.

Lamb Electric
FORMERLY Black & Decker Electric
SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

This tool for punching 3/16" thick O.H. steel sheet was made from a tool steel that promised to provide the *toughness* needed on the job. But excessive wear meant that the punch had to be reground after 190,000 holes had been punched.



Which OF THESE TWO TOOLS Will Stay On The Job Longer and Increase Machine Output Per Month?

This punch made from *Stentor* tool steel provided just the right combination of toughness and wear resistance for the job. With it, production jumped over 100% —to 387,000 holes between grinds!

here is WHY one tool does a better job...

Good tool steel is only *one* of the answers to getting tools that stay on the job longer.

But to get best possible results, you need more than that.

A tool giving 100% more production isn't just a stroke of luck! The tool room foreman knew what he needed for the job. He had found a *definite system* for picking the one tool steel that would do the job best. And as the heat treater had complete, easy-to-use instructions, they got real results right off the bat!

You can do the very same thing, by simply following the steps on the opposite page. Carpenter can give you a *definite system* for quickly finding the right tool steel for each job. You'll save time and have fewer tools to make. And when you put Carpenter's heat treating information to work on your jobs, watch the headaches disappear.

To find the road that leads the way to better tools, more output from each machine and press, follow the steps on the opposite page.

THE CARPENTER STEEL COMPANY • 128 W. Bern St., Reading, Pa.

Carpenter **MATCHED TOOL STEELS**

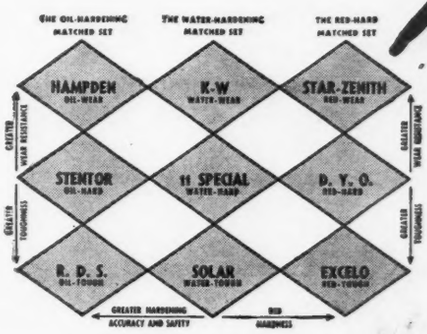
BRANCHES AT Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, Providence, St. Louis

Follow these steps
TO GET LONGER TOOL LIFE!

1 *Get acquainted* with the Matched Set Diagram

These are really Matched Tool Steels, as one picks up its job where the other "leaves off."

The key steel is the one in the center, No. 11 Special, a straight carbon, tough timbre, water-hardening tool steel. When you have a tool to make, you first find out if it can be made from No. 11 Special. If the answer is "Yes", you go no further. But when the answer is "No", you use the diagram to point the way to the tool steel that will do the job. For greater wear resistance, you go north. For greater hardening accuracy and safety, you move west. Just follow the diagram.



2 *Ask for a copy of* this Tool Steel Manual

It carries the *Matched Set Diagram* one step further.

In addition to helping you get the most from the diagram, this Manual contains an 80-page *Tool Index and Steel Selector*. Just flick the indexed pages to find the tool steel recommended for any one of more than 200 types of tools! And the *Carpenter Matched Tool Steel Manual* is saving time in heat treating departments, too. It gives complete, simplified heat treating instructions that protect the hours of skilled labor that go into tool making.

For your free copy of the *Matched Tool Steel Manual,* just drop us a note on your company letterhead.

3 *Make use of* this Tool Steel Experience

In your tool room, heat treating department or production shop—here is another way to help get the most from every pound of tool steel you use.

Get in touch with your nearby Carpenter representative and let him put his diversified experience to work for you. He knows tool steel inside and out, and can offer practical suggestions that get problems licked faster. Get in touch with him about that trouble-shooting job of yours, and he will help you get started on the Matched Set Method.

The Standard Tool Steels of Industry

When History Repeats Itself.....

KING ARTHUR will have no use for Merlin's magic • • not when he can *FLY* about his kingdom

Bumping off the opposition at a rate of 960 men a day won a kingdom for the valiant King Arthur. Relying upon the mumbo-jumbo dished up by Merlin the Magician was the main reason the kingdom was lost. Today, Merlin would be just another unemployed prestidigitator hoping for a week's billing at the Palace, because good King Art would rely on his Piper Super Cruiser to FLY about his kingdom getting first-hand information on how things were going.

In every type of business where large territories must be traversed frequently and swiftly, the dependability and economy of air travel is proving itself invaluable. Making travel by air even more dependable and economical is a task faced by all aircraft designers . . . a task made much easier by the structural advantages created through strong, yet lightweight, OSTUCO Seamless Steel Tubing. The Ohio Seamless Tube Company, a pioneer manufacturer of steel tubing, contributes experienced craftsmanship, expert research and on-time delivery as its share in the continued development of all U.S.-built aircraft.

THE OHIO SEAMLESS TUBE COMPANY

OSTUCO SHELBY OHIO

SALES OFFICES: Chicago 6, Illinois, Civic Opera Bldg., 20 North Wacker Dr.; Cleveland 14, Ohio, 1328 Citizens' Bldg.; Detroit 2, Michigan, 2857 E. Grand Blvd.; Houston 2, Texas, 927 A M & M Bldg.; Los Angeles, Calif., Suite 200-170 So. Beverly Drive, Beverly Hills, California; Moline, Illinois, 225 Fifth Avenue Bldg.; New York 17, New York, 70 East 45th Street; Philadelphia 9, Pa., 123 S. Broad St.; St. Louis 6, Missouri, 1230 North Main St.; Seattle, Washington, 1911 Smith Tower; Syracuse, New York, 501 Roberts Ave.; Tulsa 3, Oklahoma, Refining Engine & Equipment Co., 604 Ten E. 4th St. Bldg.

• Canadian representative: Railway & Power Engineering Corp., Ltd. Hamilton, Montreal, Noranda, North Bay, Toronto, Vancouver, Windsor and Winnipeg.

Plant and Main Office
SHELBY, OHIO

MANUFACTURERS OF SEAMLESS AND ELECTRIC-WELD STEEL TUBING

The reasons for this cable's superiority are no more secret than its remarkable performance record under the world's most adverse flying conditions. An outer sheath of tough synthetic rubber over an impregnated inner braid of glass yarn provides both greater mechanical strength and greater resistance to heat, cold, oil, moisture and corona. You can have Packard high-altitude aircraft ignition cable with either a steel or copper conductor . . . but you can't have a better cable for *any* flying conditions.

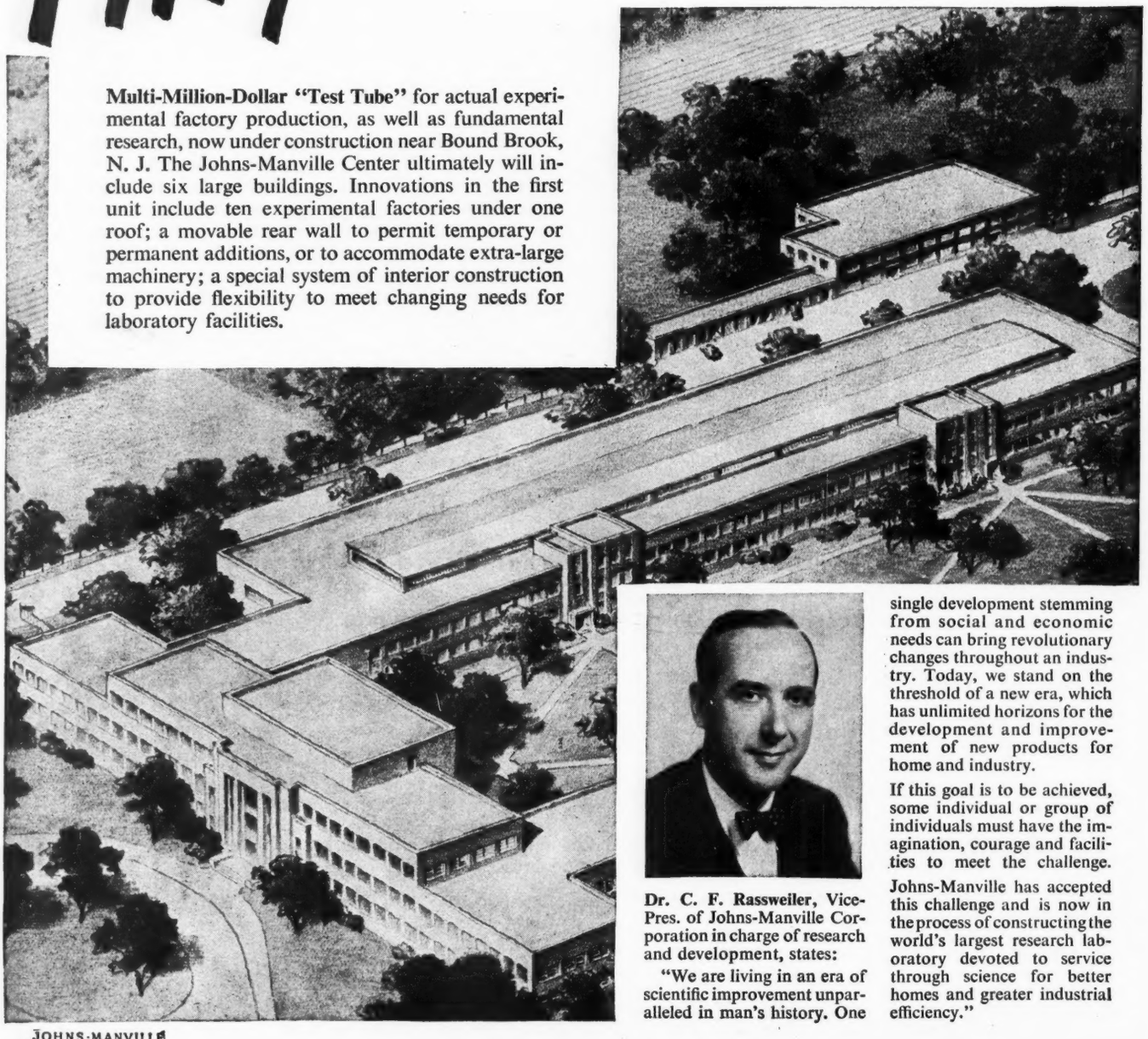
Packard

REG. U.S. PAT. OFF.

Packard Electric Division, General Motors Corporation, Warren, Ohio

Johns-Manville Announces

Fifty Million Dollar



Multi-Million-Dollar "Test Tube" for actual experimental factory production, as well as fundamental research, now under construction near Bound Brook, N. J. The Johns-Manville Center ultimately will include six large buildings. Innovations in the first unit include ten experimental factories under one roof; a movable rear wall to permit temporary or permanent additions, or to accommodate extra-large machinery; a special system of interior construction to provide flexibility to meet changing needs for laboratory facilities.

Dr. C. F. Rassweiler, Vice-Pres. of Johns-Manville Corporation in charge of research and development, states:

"We are living in an era of scientific improvement unparalleled in man's history. One single development stemming from social and economic needs can bring revolutionary changes throughout an industry. Today, we stand on the threshold of a new era, which has unlimited horizons for the development and improvement of new products for home and industry.

If this goal is to be achieved, some individual or group of individuals must have the imagination, courage and facilities to meet the challenge.

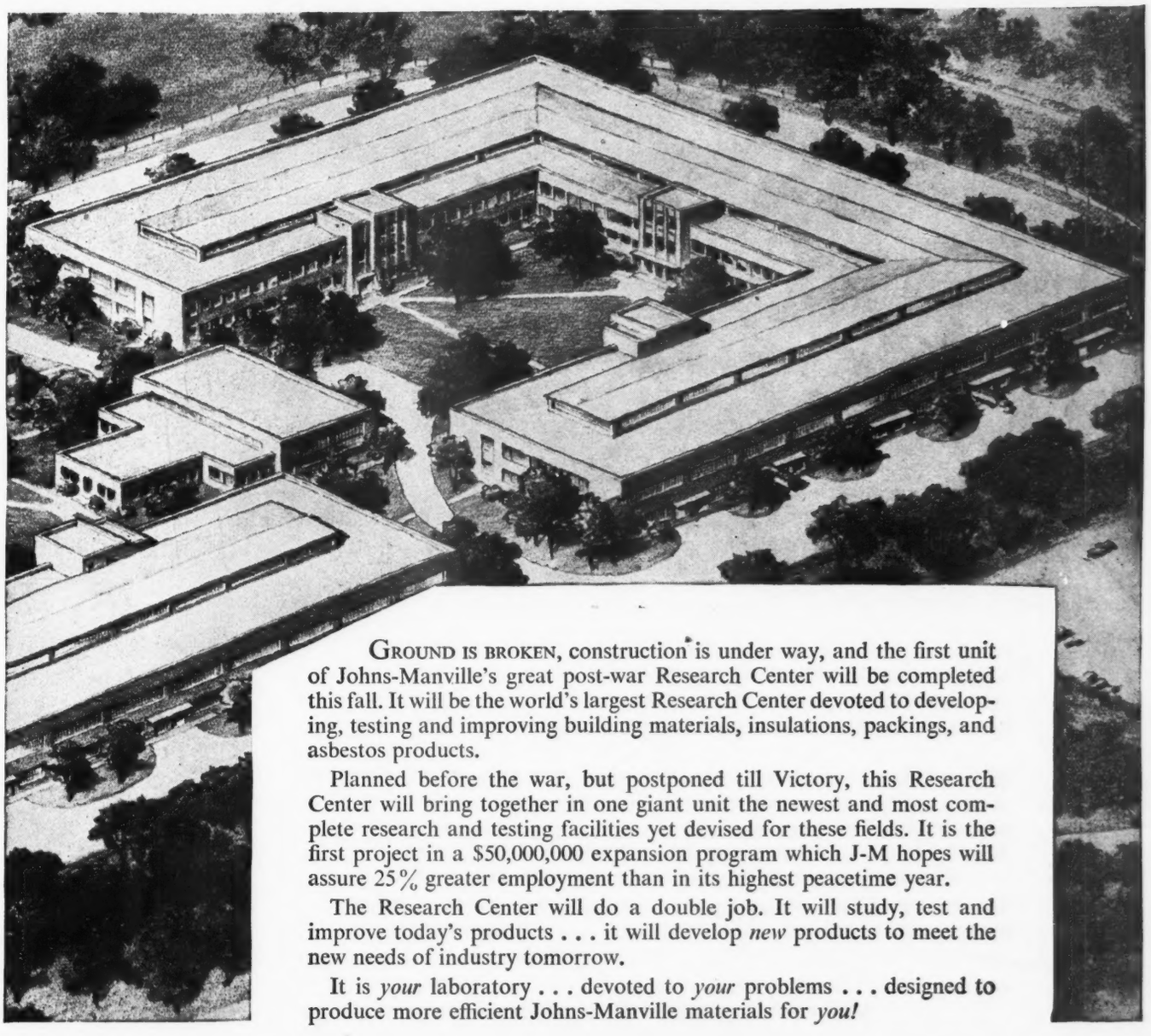
Johns-Manville has accepted this challenge and is now in the process of constructing the world's largest research laboratory devoted to service through science for better homes and greater industrial efficiency."

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

Expansion Program

to include World's Largest Research Center for Building Materials, Insulations, Packings, and Asbestos Products



GROUND IS BROKEN, construction is under way, and the first unit of Johns-Manville's great post-war Research Center will be completed this fall. It will be the world's largest Research Center devoted to developing, testing and improving building materials, insulations, packings, and asbestos products.

Planned before the war, but postponed till Victory, this Research Center will bring together in one giant unit the newest and most complete research and testing facilities yet devised for these fields. It is the first project in a $50,000,000 expansion program which J-M hopes will assure 25% greater employment than in its highest peacetime year.

The Research Center will do a double job. It will study, test and improve today's products . . . it will develop *new* products to meet the new needs of industry tomorrow.

It is *your* laboratory . . . devoted to *your* problems . . . designed to produce more efficient Johns-Manville materials for *you!*

Manufacturers of 1200 Products for Home and Industry

Developed for all types of aircraft, the new *PESCO* Carburetor Pump prevents carburetor icing under operating conditions of extreme cold by pumping a positive, metered flow of alcohol or other nonfreezing fluid to the carburetor.

This new *PESCO* pump is *small* . . . its greatest length is only five and one-eighth inches; *light* . . . it weighs only 2.4 pounds; and *simple in design* . . . a minimum number of parts makes it unusually easy to service when necessary. It will handle flows up to 12 g.p.h. at pressures up to 120 p.s.i. It features the new *PESCO* 27-volt, d.c., electric motor designed and built specifically for aircraft use.

In a modified version that permits flows up to 40 g.p.h. at pressures up to 50 p.s.i., this new pump can be used as a fuel booster pump in private type planes. For complete information write Department 6A.

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories and Aircraft Electric Motors . . . Performance Points to PESCO First.

DIVISION BORG-WARNER

Pesco PRODUCTS CO.

11610 Euclid Avenue
Cleveland 6, Ohio

MANUFACTURERS OF ENGINEERING B-W PRODUCTION SUPERCHARGERS

STAINLESS STEEL *is going places*

and

SOLAR *leads the way*

Tough, resistant stainless steel has been used for years to combat corrosion and heat... the one best metal for the purpose. Yet many a company has tried to use stainless and has had to give it up... defeated by inability to shape this difficult metal into complex designs.

Now however, the old engineering nightmare of curving and bending stainless sheet has been eliminated by development of Solar's exclusive Sol-A-Die process. Today Solar can produce stainless steel parts, engineered to amazingly close tolerances, *almost regardless of shape.*

Solar has been the dominant leader since 1931 in producing intricate stainless steel parts for the aviation industry (exhaust systems and jet engine parts). Now Solar leads in showing how stainless steel can "go places" in solving corrosion and heat problems for all industry.

Compare the *hourly cost* of Solar Exhaust Systems

Lockheed has proved in flight operations that Solar-built aircraft exhaust systems have "twice the life expected". That's double the hours... double the air mileage... and means appreciable money saving. Consult Solar about *longer lasting* exhaust systems that will save *you* money.

SOLAR
STAINLESS STEEL

SOLAR AIRCRAFT CO., SAN DIEGO 12, CALIFORNIA • DES MOINES 5, IOWA • 60 E. 42nd STREET, NEW YORK 17, N. Y.

STOP

WHERE YOU WANT TO!

NEW SAFETY LANDING DEVICE ...CAA APPROVED

Aircraft Devices Co. announces a new safety landing device for light planes. It is a stabilizer and will permit the pilot, in case of an emergency, to land in a short field *in complete safety!*

With the stabilizer, which works manually from the fuselage to the tail, the pilot is able to come in at a steeper angle of approach without danger of stalling and can apply his brakes much more sharply than formerly so as to stop in a considerably shorter run. This permits the pilot to land *where* he wants to, and eliminates the hazard of trees and telegraph lines which usually block emergency landing fields.

This is a completely new departure in the personal plane field—is patented and CAA approved!

FEATURE: The stabilizer does not alter the flight characteristics. When not in use, you don't know it is in the plane!

FEATURE: Inexpensive first cost—simple installation—practically no maintenance!

FEATURE: Manually controlled—lightweight!

We urge manufacturers and owners of small planes to ask us for full details. Write today.

Aircraft Devices Company

WINGS FIELD • AMBLER • PENNA.

"Another convert to the LOYAL ORDER OF NOODLERS!" said Nilmerg

DESIGNER: Is that a new secret Society?

NILMERG: There's nothing secret about it. I see you using one of those wonderful COLUMBUS Crayon Pencils — therefore I know you are a Noodler.

DESIGNER: You refer to my practice of noodling up drawings by giving them extra brilliance and *verve* with broad strokes of this thick crayon pencil?

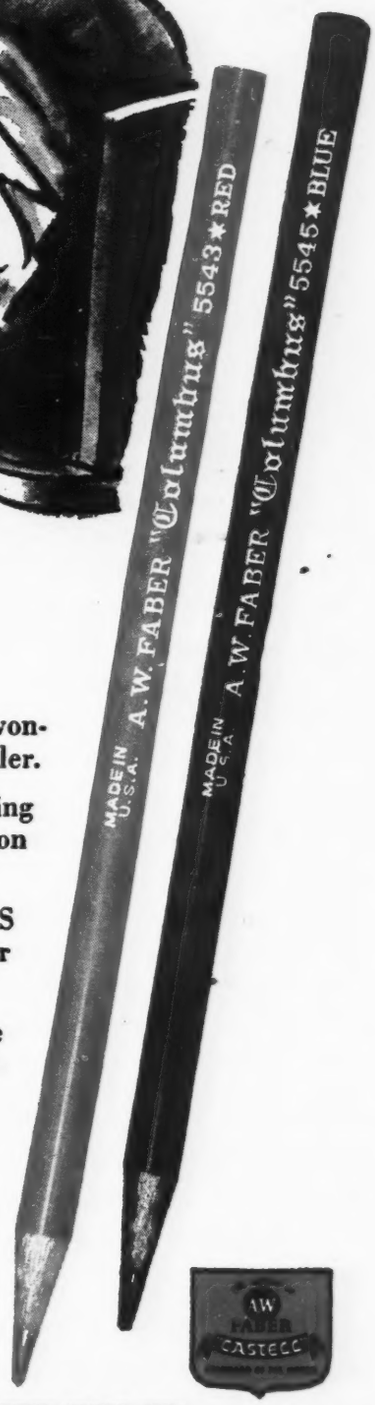
NILMERG: Indubitably. And that's just the pencil for it, too. COLUMBUS Colored Crayon has a wax composition with superb *adhering* qualities for broad area layouts, sketches, renderings, map making, etcetera.

DESIGNER: Want to know a trade secret? COLUMBUS Crayon makes me feel like a bloomin' Botticelli. I get vivid effects that go over swell with clients.

NILMERG: I have heard many artists, architects, engineers and draftsmen express similar sentiments.

DESIGNER: Little man, you are a benefactor to the Knights of the Drawing Table.

NILMERG: Thank you — and when ordering from your Dealer, be sure to get the whole COLUMBUS range — red, blue, black, brown, orange, white, yellow. vermilion, carmine, purple, green, light green, and combination red-and-blue.



A.W. FABER INC. NEWARK, N.J.

COLUMBUS THICK COLORED *Crayon Pencils*

Oh, my aching aileron!

Ah-h, your father's pinfeathers! Here I am, barrel-rolling calmly in a cirrus, when *wham!* I'm flat on my longitudinal axis. No sooner do I shake the kinks out of my tail than *wham!* I catch his propwash right in the beak.

Not that I object to you amateurs taking over the air, you understand. But use a little discretion, will you? Leave a little something for us birds!

Oh, my aching aileron! Here he comes again.*

*Now, now, our fine feathered friend. Things aren't as bad as they seem. In fact, brighter days are on their way . . . on their way with the new WACO. Come this fall, you can see for yourself the brilliant new WACO, embodying the best and latest aircraft design. So for the best in flying: Watch for the new WACO! THE WACO AIRCRAFT COMPANY, 116 Peters Avenue, Troy, Ohio, U.S.A.

SINCE 1922 • *BETTER* PLANES FOR *BETTER* FLYING

WACO AIRPLANES

Waco

"With Gulf Electro Cutting Oil we get more production per tool grind"

says this Foreman

Actual photo of a Machine Shop Foreman (right) consulting with a Gulf Lubrication Service Engineer on results with Gulf Electro Cutting Oil in machining various parts on automatic screw machines.

"When we switched to Gulf Electro Cutting Oil, we noted an immediate improvement in the overall efficiency of our automatics," says this Foreman. "We credit this oil particularly for a big increase in production per tool grind—it helps keep our tools sharp."

Gulf quality cutting oils can give you a vital advantage in machining efficiency that may help you make substantial cuts in unit production costs. Here's the important reason: Every Gulf cutting oil has specific properties which insure better performance on certain types of jobs!

It will pay you to get the complete story of the advantages of Gulf cutting oils. Call in a Gulf Lubrication Service Engineer today and let him show you how they can help you improve your machining practice. Write, wire, or phone your nearest Gulf office.

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Gulf Electro Cutting Oils A, B and C
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Please send me, without obligation, a copy of the booklet, "Gulf Cutting Oils," which includes a helpful Machining Guide.

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Company.....

Title.....

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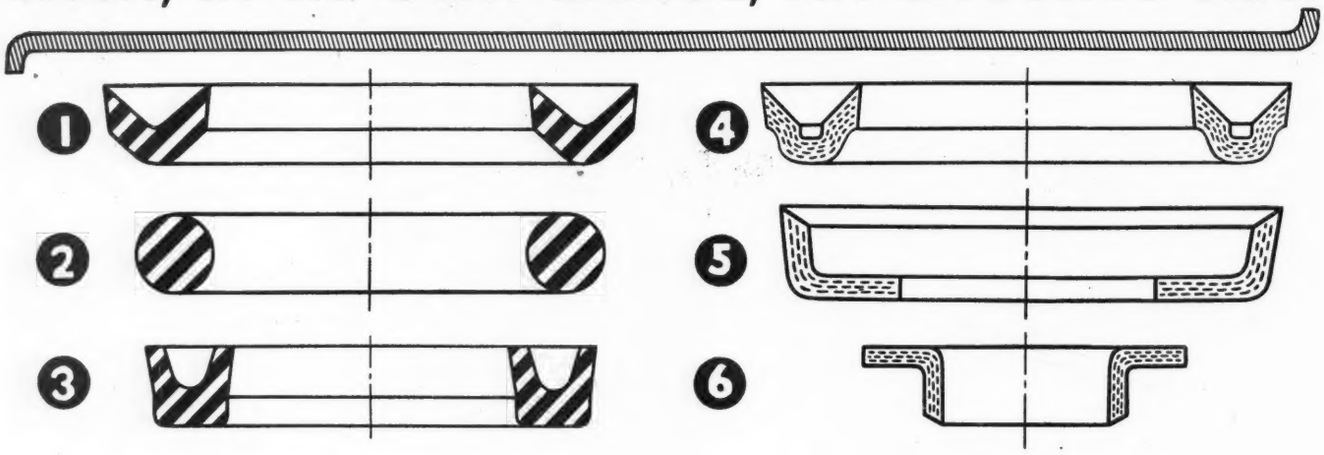
LINEAR MOULDED PACKINGS

⅛" to 72" inside diameter . . .

EACH, IN ITS OWN RANGE, AN EFFECTIVE SEAL



HOMOGENEOUS TYPE

Linear moulded synthetic rubber seals are normally furnished in general purpose rubber compounds of exceptionally high quality, which are adapted to a wide range of temperatures, pressures and hydraulic fluids.

They may also be supplied in a number of special compounds, to meet unusual service requirements. Linear's lists of standard sizes are issued for your convenience, but these packings can be fabricated to any particular dimensions required.

1 LINEAR TYPE 1815, V-RING PACKING; manufactured in standard sizes from ⅛" to 15" I. D. Recommended for pressures of 0-2000 p.s.i., where an exceptionally dry seal is required.

2 LINEAR TYPE 1820 & 1866, O-RING PACKING;* supplied in standard sizes from ⅛" to 15½" I. D. Recommended for pressures of 0-1500 p.s.i., where installation space is limited or where low cost, simplified assembly is a primary consideration. In conjunction with Linear type 2575 or 2675 backup rings, O-Rings are suitable for hydraulic pressures up to 3000 p.s.i.

3 LINEAR TYPE 1825, U-CUP PACKING; available in standard sizes from ⅛" to 3" I. D. Recommended particularly on installations where extremely low frictional drag is required.

FABRIC REINFORCED TYPE

Linear fabric reinforced packings are made in five standard styles, each designed for certain operating conditions. They are designed and proven to give maximum service life and will withstand the most rigorous usage for unusually long periods. These packings can be provided in sizes to meet the individual needs of the user.

Your inquiries should include a statement of maximum pressure, temperature range and the fluid to be handled.

4 LINEAR "PAR" PACKINGS; for *larger* installations beyond the scope of Linear type 1815 packing. Recommended for use on heavy industrial equipment, involving highest temperatures and pressures and excessive working tolerances. Linear "Par" packings can be supplied in split rings for any diameter up to 72"

5 LINEAR PISTON CUPS; recommended for installations on pneumatic and hydraulic pistons where available space is somewhat limited and long service life is of first importance.

6 LINEAR FLANGE PACKINGS; recommended for installations on piston rods and hydraulic rams where space is limited and long life necessary. This type of seal is frequently used as a piston rod wiper, where rod is likely to be exposed to grit or dirt.

---

*Covered by Christensen United States Patent No. 2,180,795; all O-Rings sold by Linear are manufactured under royalty agreement with patentee.

With over 40 years' experience in the design and application of mechanical packings for every purpose, we offer our engineering consultation in connection with your hydraulic design problems. No obligation.

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AIRPLANE parts in great variety have been made of Formica because it combines a number of qualities that are available in no other material.

It is lighter than aluminum and is as strong as cast iron. It is non-absorbent and stable in dimensions under extreme changes of humidity. It has a low co-efficient of thermal expansion and is unaffected by wide ranges of temperature. It does not corrode or show surface failure by chemical reaction with the atmosphere.

It can be molded, post-formed, machined and can therefore be worked by the widest variety of production techniques.

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Stops
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Instrument Panels
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Split Sprockets
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Instrument Dials
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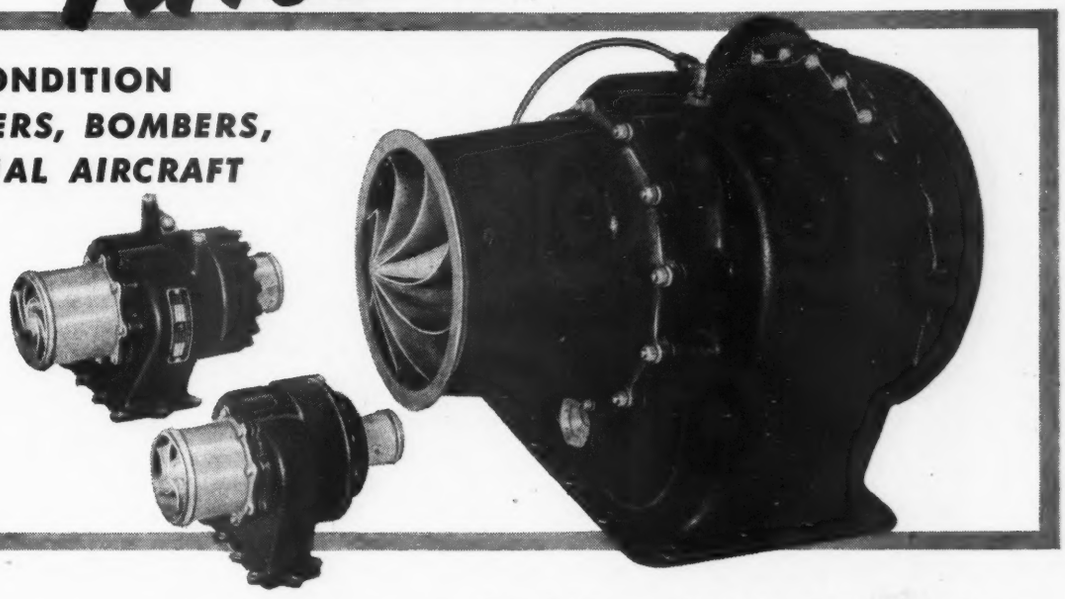
Handles
Knobs
Grips
Electrical Bushing

COOLING TURBINES

TO AIR CONDITION
JET FIGHTERS, BOMBERS, COMMERCIAL AIRCRAFT



Revolutionary New Development Makes Possible High Speed, Pressurized Flight

AiResearch Air Expansion Turbines make possible living room comfort in the pressurized cabins of the new Lockheed Constellation, the Douglas DC-6 and the Consolidated 240, three of America's fastest and most luxurious transport ships, soon to be in service. These turbines will be utilized in systems which cool the hot compressed air from the cabin supercharger before it reaches the pressurized cabin. The result is a comfortable, air-conditioned cabin at any altitude, at any speed and in any climatic condition.

AiResearch is the first to apply the principle of the expansion air turbine to aircraft airconditioning. It cools hot supercharged air by expanding it from high pressure down to cabin pressure and taking "work" out of it.

A complete line of air expansion turbines, both low and high pressure, weighing from 3 to 65 pounds and with temperature drops ranging from 45° to 135° have been developed.

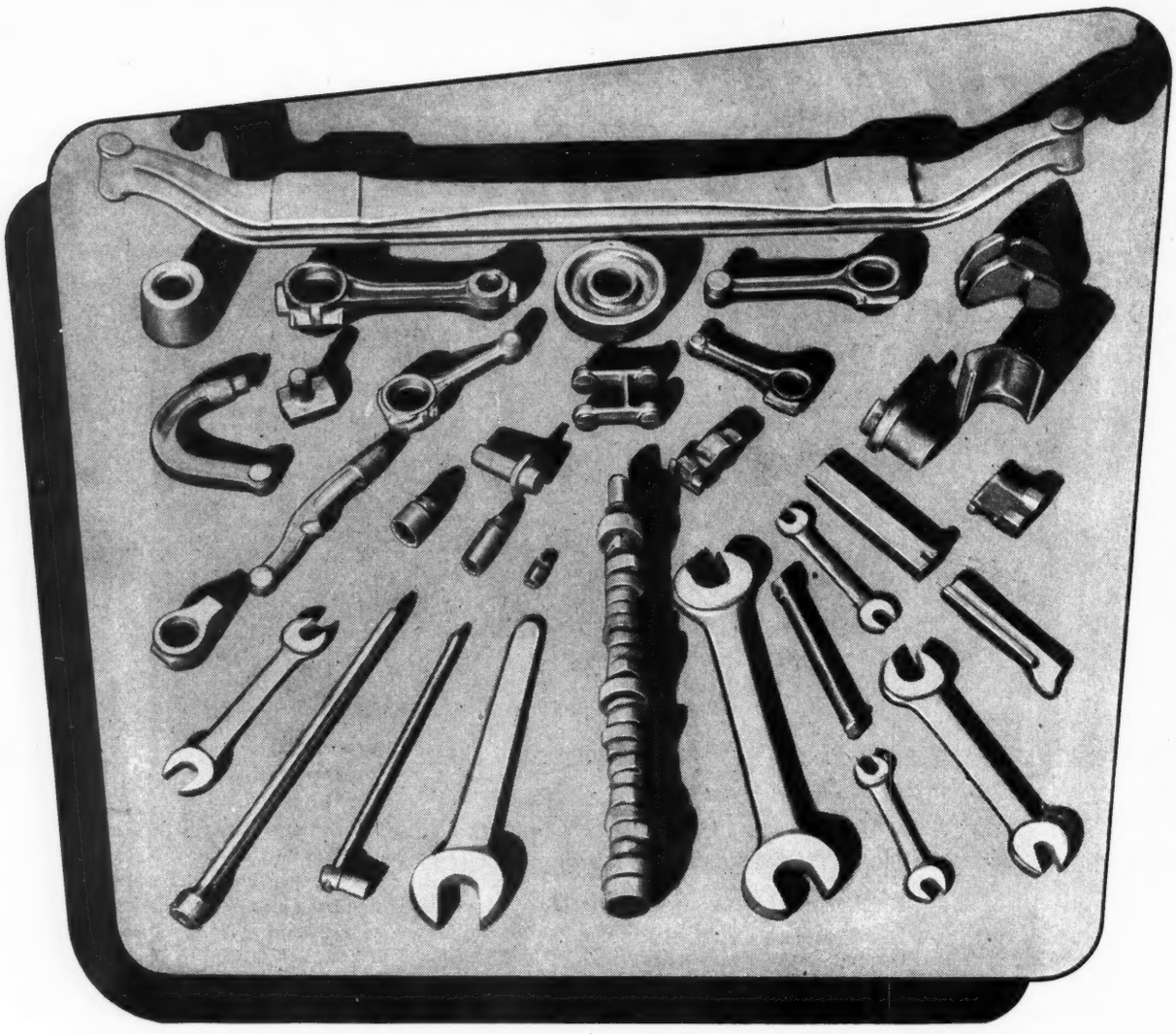
Operating at speeds from 18,000 RPM to 100,000 RPM, the units incorporate a self contained lubrication system, and require air as the only source of power. The largest single turbine unit now in production will make available 12 tons of refrigeration for cooling cabin air.

AiResearch cooling turbines are being used in new planes of Douglas, Lockheed, Consolidated Vultee, North American, Republic and Northrop. The AiResearch background of engineering skill and research is available to help solve *your* AIRCRAFT airconditioning problems. AiResearch Manufacturing Company, Los Angeles 45, California.

TYPE	AIRFLOW PER MINUTE	TURBINE WEIGHT	TEMPERATURE DROP	R. P. M.	SUITABLE FOR
Simple	7 lbs.	3 lbs.	135°	100,000	Jet Fighters
Simple	10 lbs.	5 lbs.	135°	85,000	Jet Fighters
Simple	20 lbs.	10 lbs.	135°	48,000	Jet Medium Bombers
Simple	80 lbs.	34 lbs.	45°	18,000	Comm. Aircraft
Boot Strap	65 lbs.	25 lbs.	110°	32,000	Comm. Aircraft
Boot Strap	100 lbs.	65 lbs.	125°	27,000	Comm. Aircraft

AiResearch — manufacturers of AIR CONTROL equipment • Cabin Pressure Regulating Systems • Engine Oil Cooling Systems • Supercharger Aftercooling Systems • Temperature Control Systems • Engine Intercooling Systems • Automatic Exit Flap Control Systems.

AiResearch
DIVISION OF
THE GARRETT CORPORATION



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PRECISION FORGINGS

Upset or Drop Forged--Any Shape or Size up to 200 lbs.

In this postwar period of high speed production—it pays to specify Herbrand, a source of quality forgings since 1881.

Herbrand provides the latest, most modern forging facilities including steam hammers, board hammers, forging machines, bending machines, heat treating and die making equipment . . . Our forgings possess an enduring, inbuilt stamina because they are scientifically heat treated by definite process in the latest automatically controlled furnaces.

Exacting inspection by skilled men assure forgings free from defects . . . Your inquiries are solicited.

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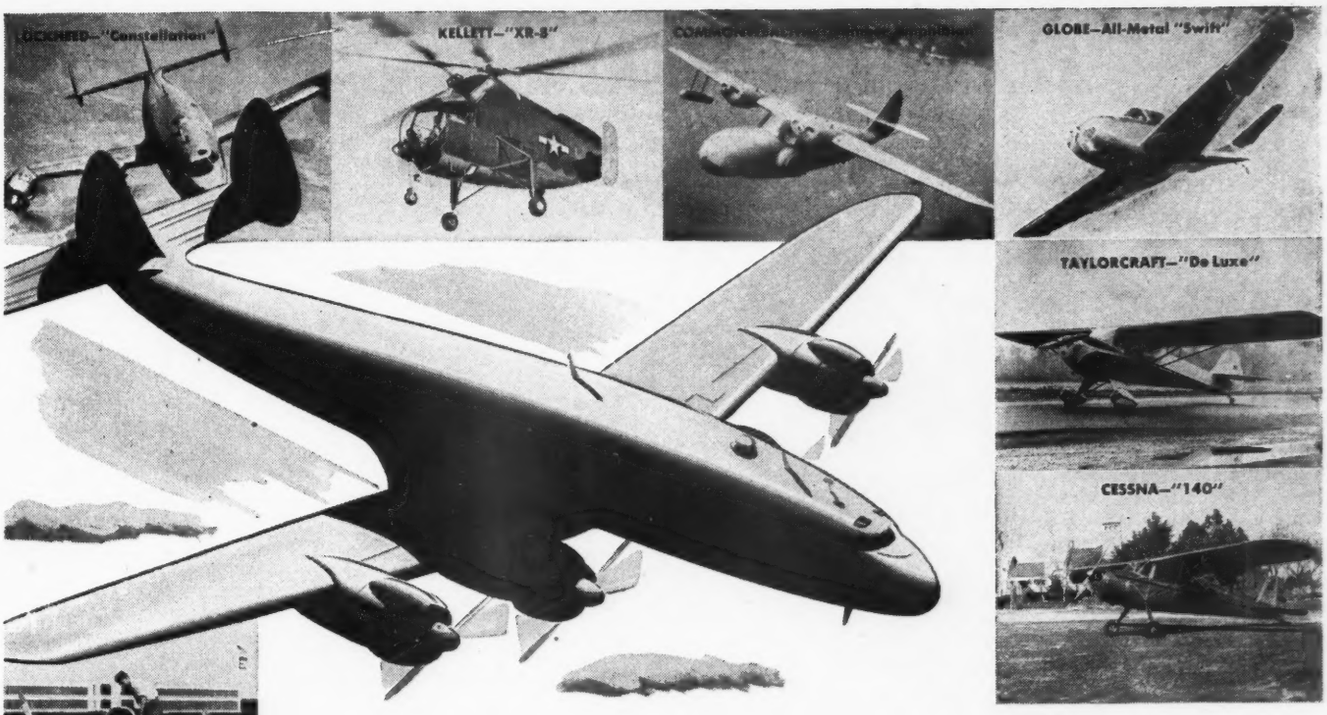

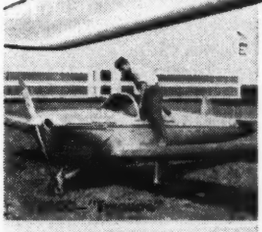

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your best guide to Peacetime Performance!

AMERICA'S BUILDERS of aircraft look to "Pittsburgh" with complete confidence for protective coatings—no matter how large their requirements or how complex their specifications!

There is no better proof of the toughness, durability and long life of Pittsburgh Aircraft Finishes than their unsurpassed performance under the exacting conditions of the war years.

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In addition to a complete line of aircraft finishes Pittsburgh offers a wide variety of industrial finishes for every need. Call on us for enlightening facts and figures. Our extensive experience often can save you time and money.

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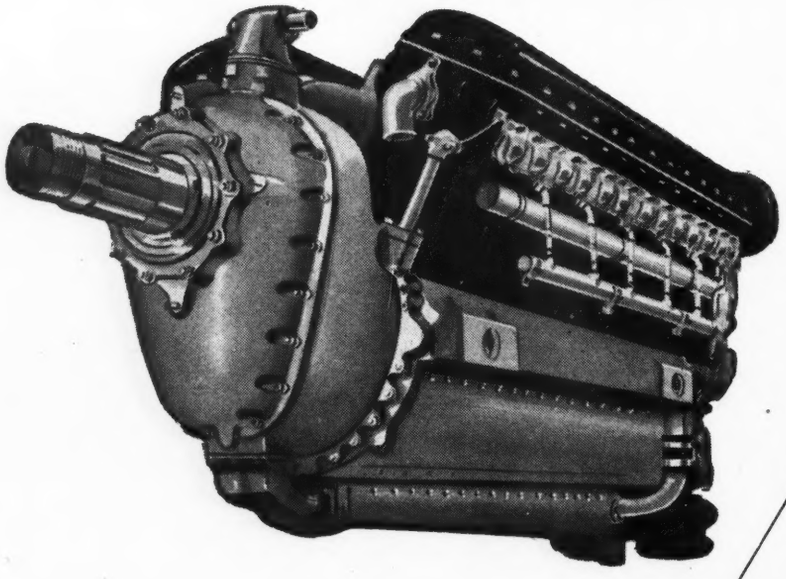
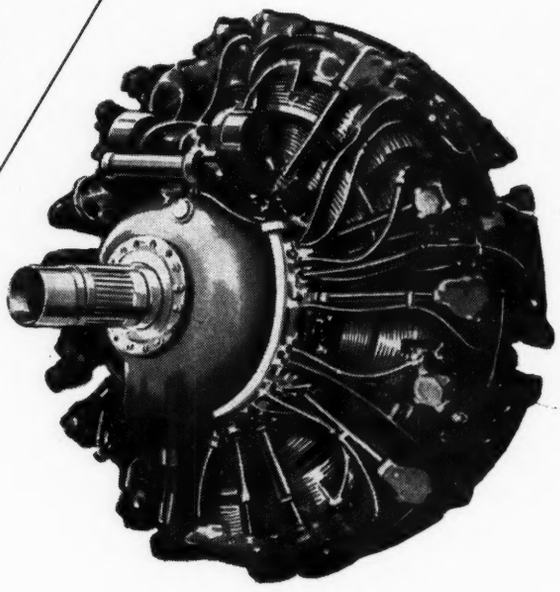
PITTSBURGH *Industrial* FINISHES

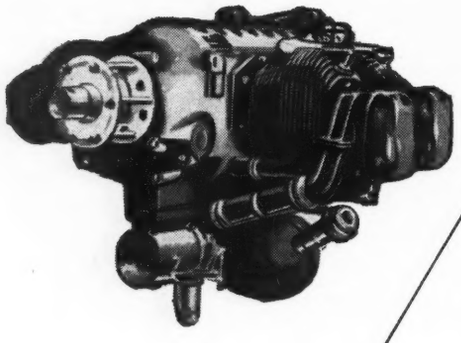
PITTSBURGH STANDS FOR QUALITY PAINT AND GLASS

HARRISON

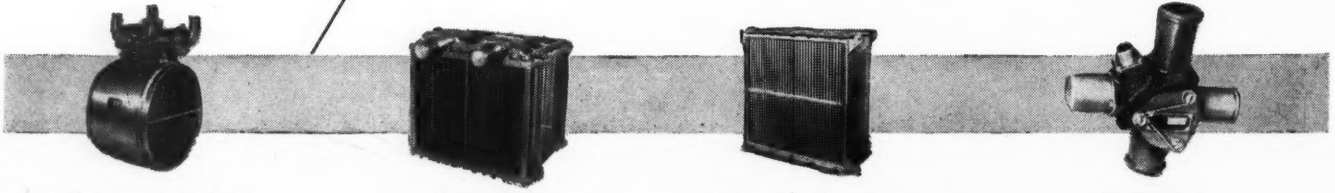
Temperature Engineering







Harrison Temperature Engineering provides a scientific approach to problems of heat dissipation and temperature control in aircraft engine operation. Harrison aircraft products meet the varied requirements of commercial, private and military aircraft.



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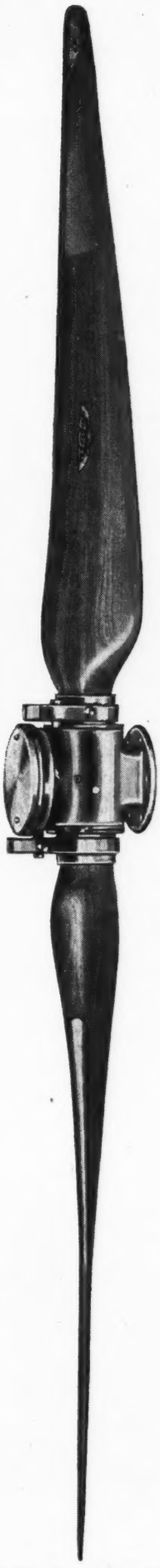
HARRISON RADIATOR DIVISION OF GENERAL MOTORS, LOCKPORT, NEW YORK

THE PROPELLER WITH PERFORMANCE



SOMETHING *New* ON THE NOSE

OF THE *New* CULVER

A new ship by Culver; a new propeller by Sensenich . . . it's a *right* combination!

Culver's first post-war presentation —the Culver "V"—is now on the line warming up for its flight into the future . . .

. . . and *right on its nose* is the new *Skyblade*—hot off Sensenich's production line—to add "pull" to every horsepower. It's the lightweight, two position, controllable pitch *propeller with performance* made by the world's largest manufacturer of wood aircraft propellers. Culver is first to specify the *Skyblade* as standard equipment. Other models—both controllable and ground adjustable—are approved for other aircraft.

SENSENICH *Skyblade*
TRADE MARK

Wherever you see aircraft, you see the famous Sensenich winged trade mark. No other propeller has been chosen so often by those who design and build America's personal planes—and those who fly them!

SENSENICH BROTHERS • Main Plant, LANCASTER, PA. • West Coast Plant, GLENDALE, CALIF.

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AIRCRAFT BATTERIES

DESIGNED TO FIT THE SPECIFIC NEEDS OF PLANES OF EVERY KIND

From the time when batteries were first used in aircraft, Exides have been the battery choice of aviation engineers, maintenance men, plane builders and plane owners. With the result that today many American built planes are Exide equipped.

Exide Batteries are supplied in several types, designed specifically to meet the needs of aircraft in each classification. And wherever they are used, Exides provide continued proof of dependability, long-life, and safety . . . plus maximum performance per pound of weight.

Exide Aircraft Battery Sales and Service Organization covers the country from coast to coast.

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Philadelphia 32
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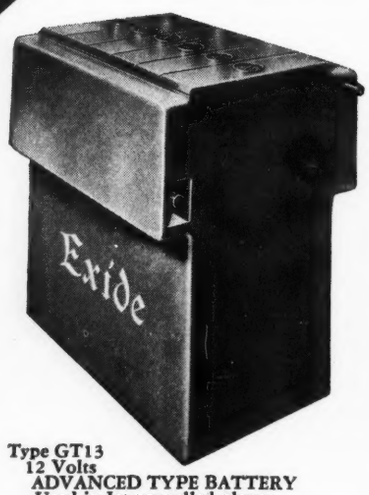
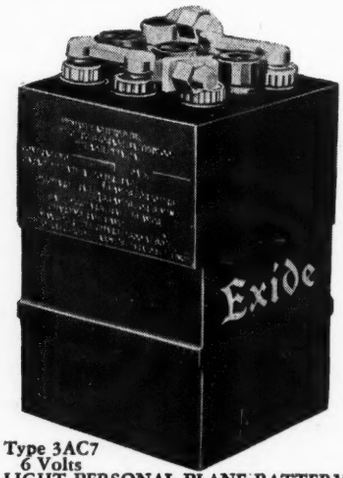
12 Volts
AIR TRANSPORT BATTERY
Used by leading airlines

Type 6TS9F
12 Volts
PERSONAL PLANE BATTERY
For lights, radio and starting

Type 12TS9L
24 Volts
MILITARY TYPE BATTERY
For military and reconverted Government planes



Type GT13
12 Volts
ADVANCED TYPE BATTERY
Used in Jet-propelled planes



Type 3AC7
6 Volts
LIGHT PERSONAL PLANE BATTERY
For ignition and small lighting loads

Strength is IN

Weight is OUT!

Two essentials in shielding in aircraft—great fatigue strength and light weight—are combined with exceptional success in Air-Shields seamless tubular shielded leads.

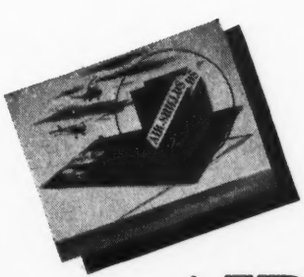
An Air-Shields installation weighs from 50 to 70 percent LESS than flexible hose-type shielding, yet will stand up to 60 pounds of air pressure at the joints. This combination of durability and extremely light weight saves hundreds of dollars per pound *every month* in airplanes.

Exhaustive, punishing tests—both in laboratories and under conditions of actual use—prove conclusively that seamless metallic tube has greater shielding effectiveness than all-braid tube. And in addition to teaming long-lived endurance and lightness, Air-Shields specialized engineering has developed 6 other vitally important features. With Air-Shields seamless tubular shielded leads: 1) Ignition system emanations are prevented from interfering with radio communications and other electronic devices; 2) Moisture cannot enter from outside or condensation occur within; 3) There is no space for formation of corona and its destructive effects on insulation of cable; 4) Vibration is isolated and controlled; 5) Possibility of metal crystallization and failure is effectively reduced; 6) In most cases, the initial cost of Air-Shields leads is below ordinary shielding.

On every important point, Air-Shields harnesses have consistently demonstrated their superiority over ordinary types of shielding. If you have a shielding problem in airplane, automobile, marine or stationary gas engines, take advantage of Air-Shields expert engineering service.

"It seems obvious, and in fact it is true, that for the same weight and type of metal a seamless metallic tube has greater shielding effectiveness than an all-braid tube."—A leading Air Corps technician, Aircraft Radio Laboratory, in Aeronautical Engineering Review.

A typical installation of an Air-Shields Harness on a Helicopter Engine.



Send for this book. It tells you why Air-Shields seamless tubular shielded leads are far superior to ordinary shielding.

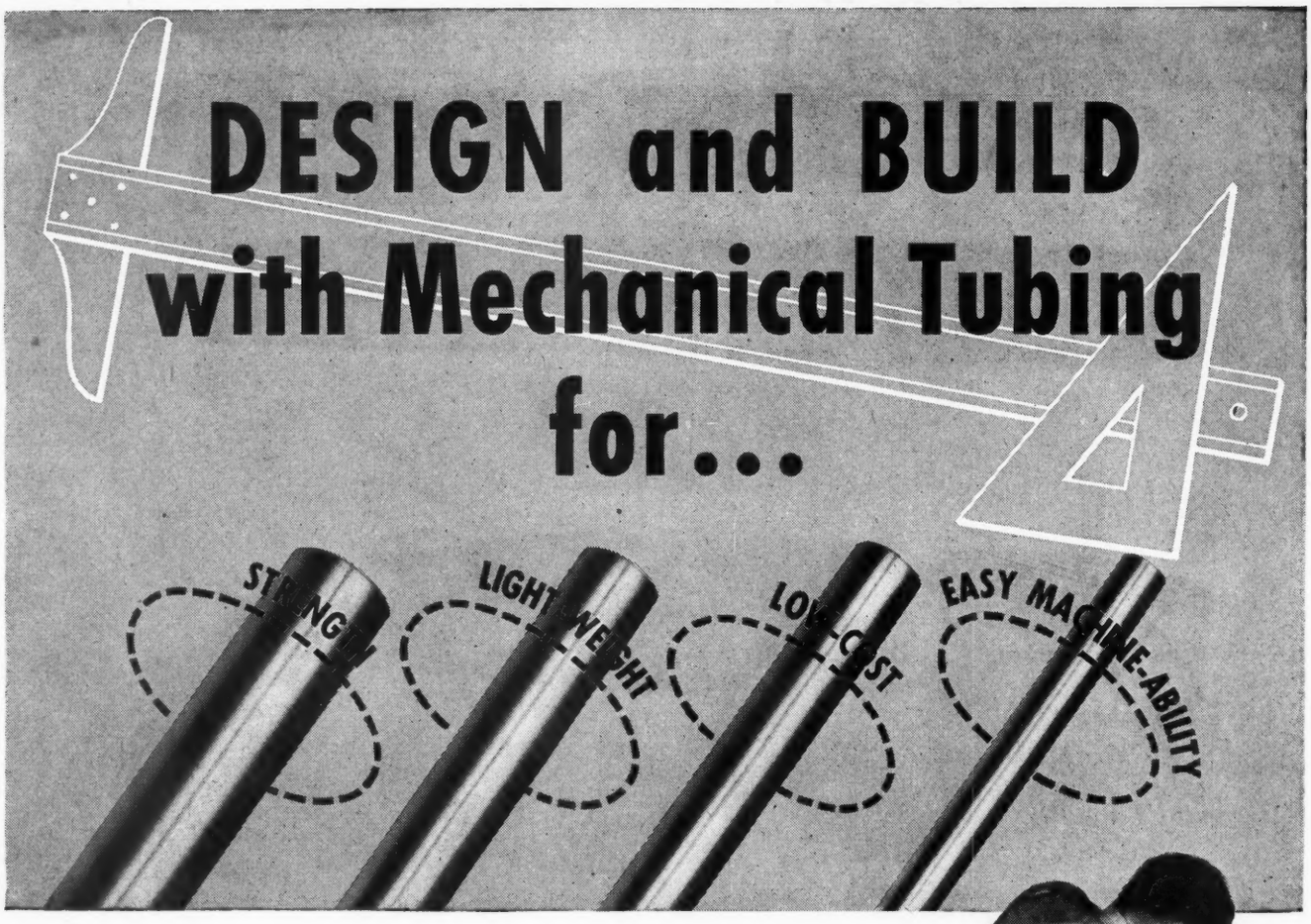
AIR-SHIELDS *Inc...*

Manufacturers of seamless tubular shielded leads, shielded spark plugs, ceramic terminal contacts and components

Hatboro, Pennsylvania

Fitting Patent Pending

DESIGN and BUILD with Mechanical Tubing for...



Specify GLOBE for Mechanical Tubing of Uniformity and Quality

GLOBE Seamless Mechanical Tubing is produced by piercing from solid billets of steel — there are no seams or welds and it offers important advantages in maximum strength with minimum weight and usually requires little machining. It is an ideal material for load bearing machine parts where strength with a minimum of weight is needed.

Its economy, compared with solid stock for the manufacture of small machine parts, is everywhere recognized. Production costs are substantially reduced because it requires little machining.

The Globe Steel Tubes Co. specializes exclusively in the manufacture of tubing. This concentration of facilities provides a dependable source of supply and assures a consistently uniform quality of product . . . Globe engineers are at your service to assist in the selection of tubing of the exact characteristics you require.

Testing and inspection of Globe Steel Tubes are regular routine. Special problems of customers are studied, too, and physical and chemical tests, spectrographic and microscopic examinations of steels are made to select the correct analysis for each customer's particular needs.

GLOBE STEEL TUBES CO., Milwaukee 4, Wis., U. S. A.

GLOBE MECHANICAL TUBING

5029

GLOBE TUBES

★ Pressure Tubes
★ Condenser & Heat Exchanger Tubes
★ Seamless Stainless Steel Tubes
★ Globeiron High Purity Iron Seamless Tubes
★ Gloweld Welded Stainless Steel Tubes
★ Mechanical Tubing

what lesson can you learn from a mighty *Air Transport?*

Perhaps the equipment you make is far removed from Lockheed air transports, but the successful solution of the application of power demonstrated in these airplanes may offer a suggestion to you. Power is transmitted from the engine through an assembly of Power Units. This assembly drives a generator, cabin supercharger, hydraulic pump and other equipment.

Foote Bros. Power Units provide a positive means of applying this power exactly where it is needed.

These compact units can actuate linear or rotary motion at remote distances from the operator. They are light in weight—compact in size to fit a confined space envelope—and can perform continuously or on a predetermined time cycle. They may be direct connected to the power source—operated through a flexible shaft—or powered by an integral motor.

Many manufacturers have found that Foote Bros. Power Units provide a successful solution to power transmission problems. Their use on the equipment you manufacture may mean a better product. Our engineers will gladly work with your designers.

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Better Power Transmission Through Better Gears

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with AIRWING

QUALITY IS THE WORD for Airwing Fabrics and Tapes. For they are manufactured under the careful supervision of experts from cotton through cutting. That's why the Airwing Trade Mark is the mark of satisfaction wherever lightweight fabrics and tapes of high tensile strength and ease of application are required.

The Airwing line includes airplane and glider fabrics, balloon and special cloths. Airwing Tapes come in a complete selection—Grade A made from long staple Pima cotton, and Lightweight—pinked edge, sealedge, biased, and pre-doped.

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Division of Reeves Brothers, Inc.
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Factory and Warehouse
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ADMA

WRITE US FOR THE NAME OF YOUR NEAREST AIRWING DISTRIBUTOR

RUGGED, ACCURATE, LIGHT-WEIGHT MOTORS AND SYSTEMS TO GIVE REMOTE MANUAL OR AUTOMATIC CONTROL..

Barber-Colman

MICRO CONTROLS *for* AIRCRAFT

Type FYLC CONTROL MOTOR. Maximum torque, 50 lb. inches. Approximate weight, 2¼ pounds. Available with or without right-angle drive.

Type BYLC CONTROL MOTOR. Maximum torque, 500 lb. inches. Weight, 3 pounds 4 ounces. Available with or without right-angle drive.

This equipment is *specially designed and built* for aircraft service. Note light weights, small sizes, and high torques indicated by brief specifications here. Barber-Colman Aircraft Controls *proved their ability* to perform accurately, reliably, and efficiently during the war. You can use them now for control of CABIN TEMPERATURE . . . ANTI-ICING TEMPERATURE . . . CARBURETOR AIR TEMPERATURE . . . CARBURETOR MIXTURE . . . CARBURETOR THROTTLE . . . and other similar purposes. *Write for further information.* Look for Barber-Colman Controls on the Leading Luxury Airliners!

Type EYLD REMOTE BULB THERMOSTAT. Weight, including bulb and tube, 1 lb. 2 oz. Dimensions, 3¼" x 3½" x 1-5/16"

Type CYLD (far right) SINGLE ELEMENT CABIN THERMOSTAT. Weight, 7 oz. Dimensions, 3¼" x 3½" x 1-5/16".

Type AYLZ (right) MICROPOSITIONER. Super-sensitive polarized relay for control circuits. Weight, 6 oz. Dimensions, 2-5/16"x1-7/8"x1-7/16"

BARBER-COLMAN COMPANY • ROCKFORD, ILLINOIS, U.S.A.

Whatever combination of conditions your springs must fight...

CORROSION • RUST • HEAT • COLD • HIGH STRESS • FATIGUE

Whatever type of spring you need...

COMPRESSION • EXTENSION • TORSION • SPIRAL • FLAT • CLIP • RETAINER • GARTER • BANANA

Consider these alloys first...

MONEL* • "K" MONEL* • INCONEL* • "Z" NICKEL* • NICKEL

There is no need to put up any longer with repeated troubles that can be avoided by using INCO Nickel Alloy springs for corrosive conditions and elevated or sub-zero temperatures.

Now, rustless, high-strength springs can be made of five different INCO Nickel Alloys to withstand corrosive attack and temperatures up to 750°F. or even higher.

And they cost so much less than special alloy springs that it is practical to use them for any application where heat, corrosion or fatigue are causing you trouble with ordinary spring parts.

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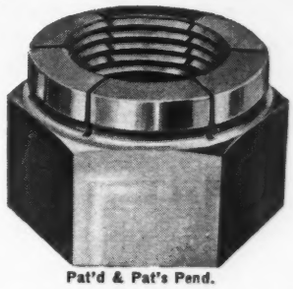

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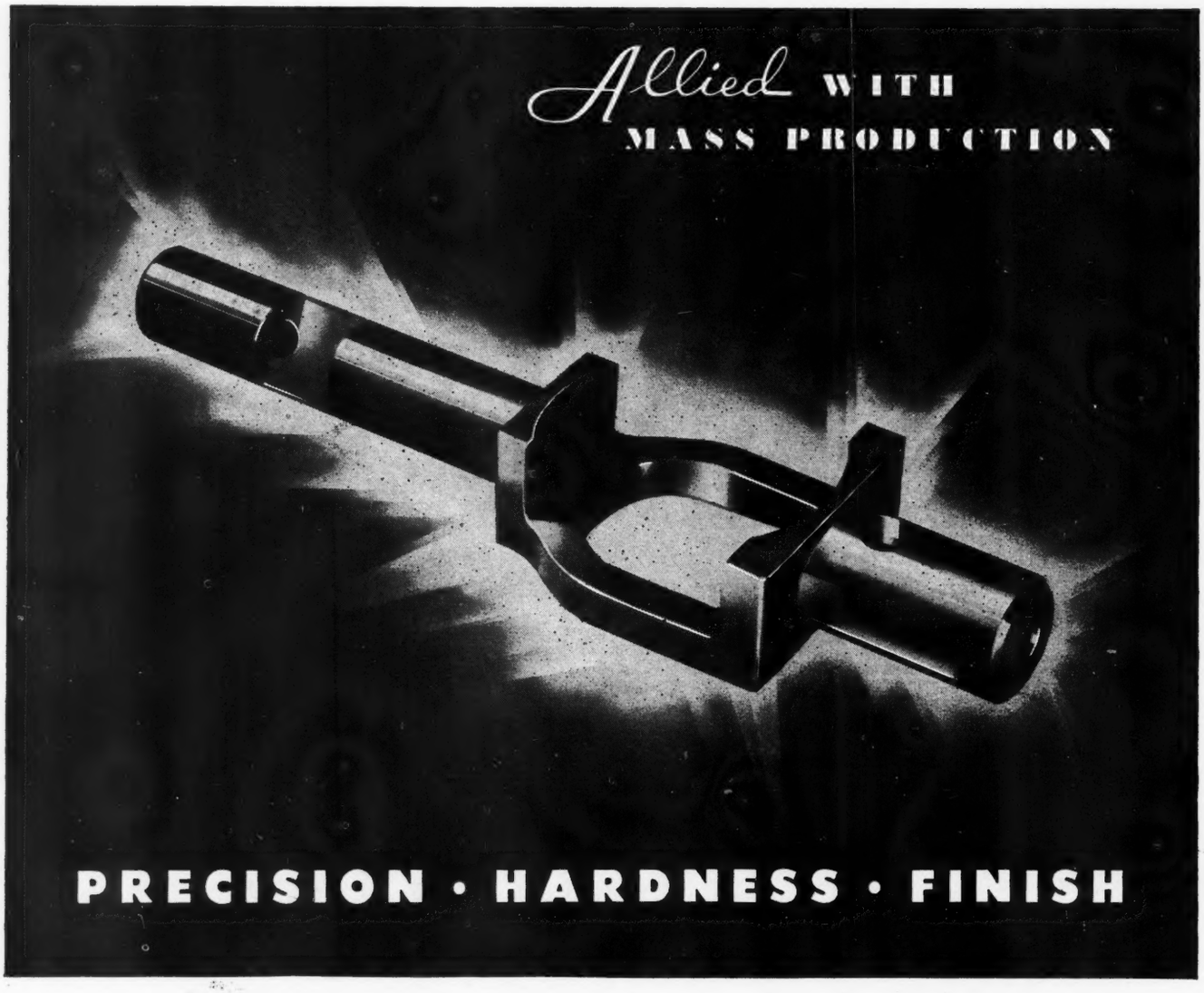

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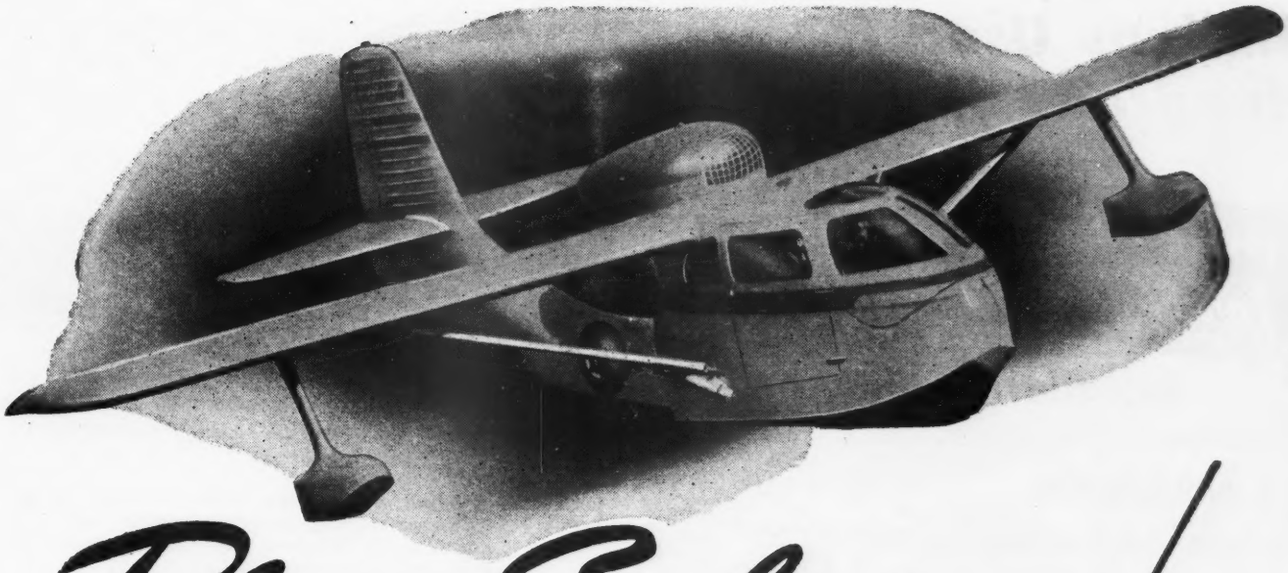

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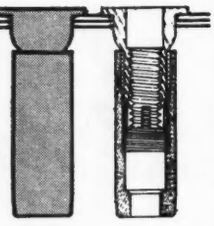
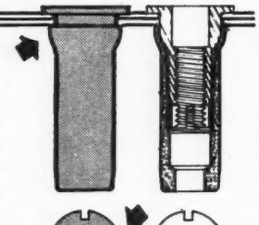
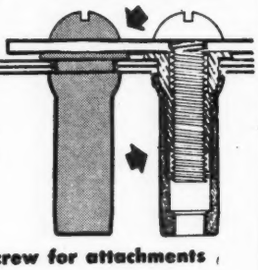


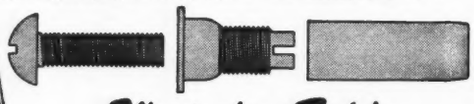
3 Draw LOK-SKRU sleeve against inner side of metal with special power or hand tool, to rivet sheets securely. LOK-SKRU head, tapped for 6, 8, or 10/32 machine screw, provides an anchor nut.



4 Screw, to fasten attachments, is locked in anchor nut by tension grip.



Disassembled LOK-SKRU with screw for attachments



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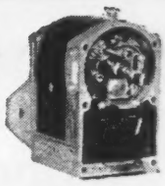

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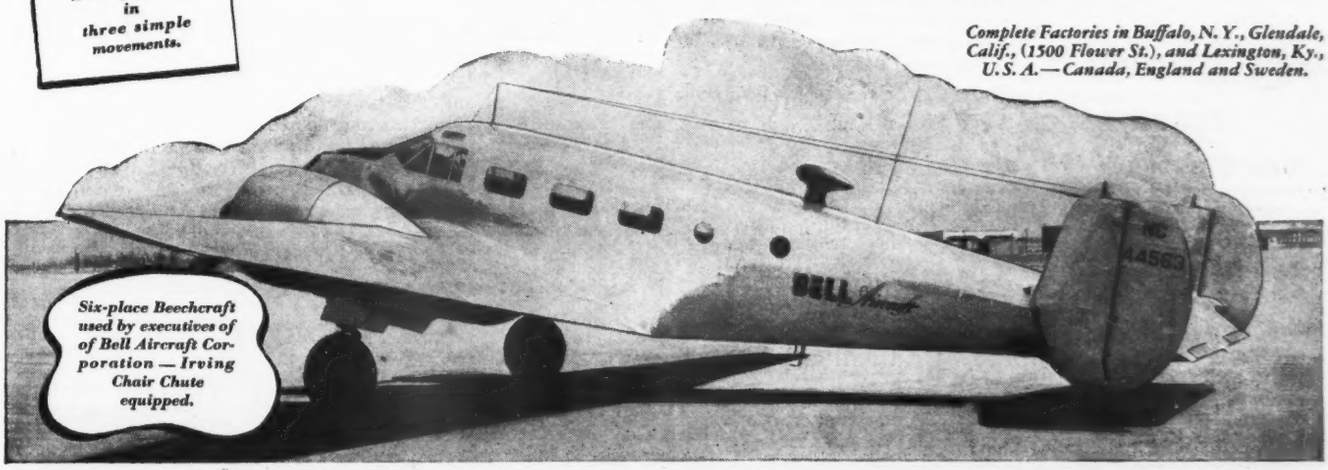

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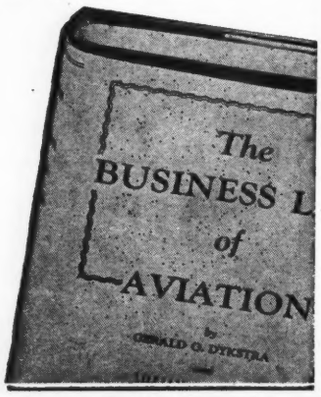

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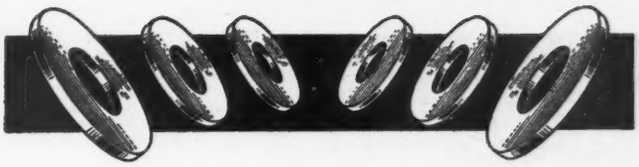

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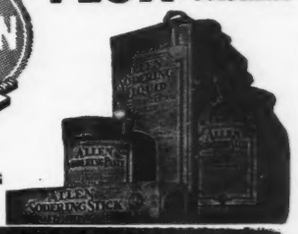

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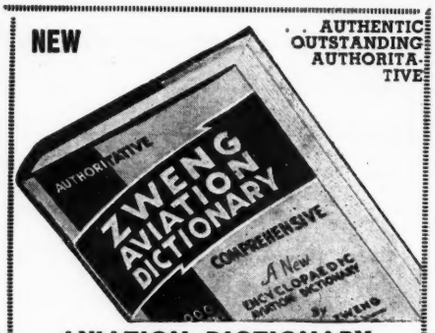

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GOVERNMENT OWNED SURPLUS HEAT TREATING EQUIPMENT

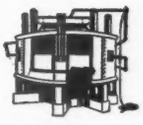
This surplus property is offered to prior claimants, including veterans of World War II.

GET IT NOW!

There is no need to hold up post war production plans because you can't get heat treating equipment. Surplus equipment of modern, high production, design—is available in quantity in every major metal manufacturing area. Furthermore it is priced at levels to permit its profitable conversion from war to peacetime production needs. But the really important factor is that you can get it *now* when you need it most.

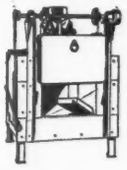
ROTARY HEARTHS

For heat treating in production operations. Semi-automatic operation and control.



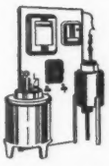
TEMPERING FURNACES

For tempering small work in production or for the tool room or laboratory.



CONTROLLED ATMOSPHERE HARDENERS

For precision tools and dies and applications where surfaces must be protected.



INDUCTION HARDENERS

The latest development in controlled surface hardening by high frequency induction.

VETERANS OF WORLD WAR II: To aid you in purchasing surplus property, a veterans' unit has been established in each War Assets Administration Regional Office.

TAKE THESE 3 STEPS

1. **Accurately Determine Your Needs**
   Check your operations and jot down the type of equipment you need, necessary capacities, ratings, etc. Where possible indicate the make of equipment you would prefer. This information we will need to locate for you suitable surplus equipment.
2. **Estimate the Cost You Can Afford**
   Here again is a guide we need in locating the right equipment for you among many hundreds of available furnaces. In pricing we give consideration to such alterations necessary to meet your specific problems.
3. **Fill In and Mail This Coupon**

To War Assets Administration: Please send me information on the following types of surplus Heat Treating Equipment:

FUEL	INTENDED USE	TYPE OR MAKE
☐ ELECTRICAL	.....	.....
☐ GAS	.....	.....
☐ OIL	.....	.....
☐ HIGH FREQUENCY INDUCTION	.....	.....

I am also interested in ☐ HEATING FURNACES ☐ MELTING FURNACES ☐ DRYERS ☐ KILNS

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Firm.....

Address.....

City.....State..... 174-3

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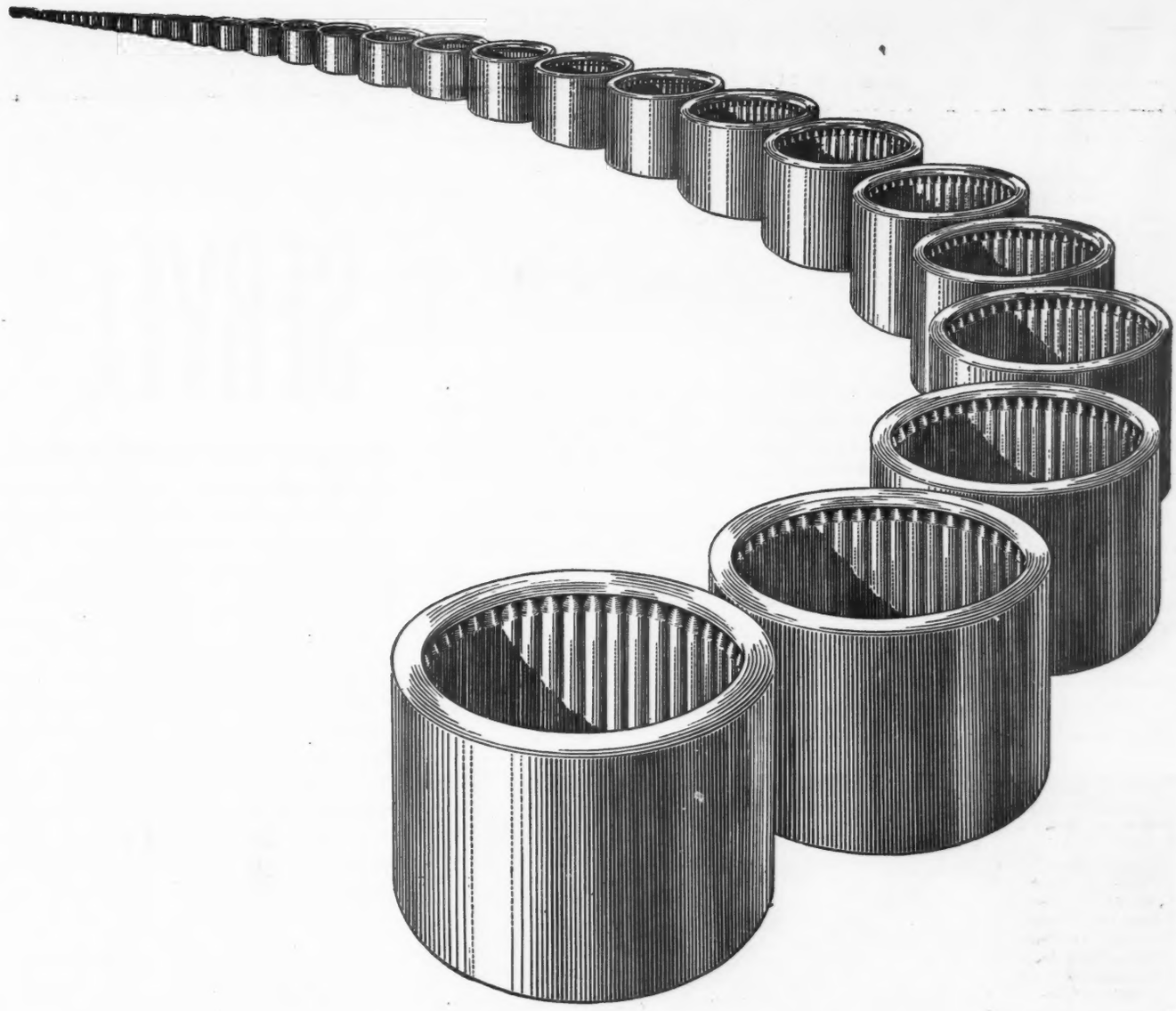

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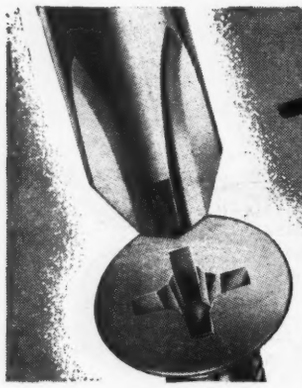
Offices in All Principal Cities

TORRINGTON NEEDLE BEARINGS



INDEPENDENT INVESTIGATOR'S STUDY SHOWS

Phillips Screws give each assembler a needed "extra hand" and costly driver skids at SERVEL

"WE couldn't possibly use slotted screws in these door panels," the chief cabinet engineer at Servel, Inc. told the investigator. "We know, from actual tests. In many places it would be impossible to guide a slotted screw with the driver except at a snail's pace, and our driver skid damage would be terrific."

TO GET THE COMPLETE FACTS on how this leading refrigerator manufacturer enlists the many advantages of Phillips Screws, the investigator asked the same questions you would ask – learned how they make big savings day after day – the kind of savings *you* can't afford to miss with today's squeeze on profits.

THIS REPORT, with others now ready, and more to come – comprise a practical manual of modern assembly methods, never-before-printed information, inside facts you'd pay good money to get, and you can have them now, FREE!

This investigator from James O. Peck Co., industrial research authorities, is visiting representative plants to get authentic facts for you on assembly savings.

HIGHLIGHTS FROM THE SERVEL REPORT

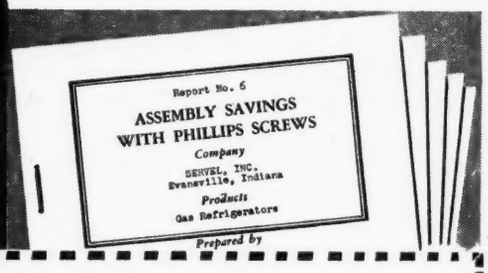
"AN ASSEMBLER WOULD NEED THREE HANDS to drive slotted screws under the rubber gasket in fastening inner door panels and even then, driver skid damage would be prohibitive. The Phillips driver is self-centering – makes it easy to guide the screw with one hand.

"IT COSTS MONEY to replace door panels punctured by skidding drivers, figuring the cost of a new panel, and time for taking out and replacing up to 43 screws. Slips are no problem with Phillips Screws. This advantage alone saves *plenty* in our big production.

"WE RAN A TEST six years ago on door assembly to prove that Phillips Screws cost much less to use than slotted. It was so convincing, no one ever suggested using slotted screws again in this application."

GET THESE REPORTS . . . READ THE COMPLETE FACTS . . . LEARN HOW YOU, TOO, CAN CUT ASSEMBLY COSTS!

All types of products are covered – metal, plastic, wood. The coupon will bring the reports ready now and the rest as they are issued. Fill it in and mail it, TODAY!



PHILLIPS Recessed Head SCREWS

Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

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2300 Industrial Trust Bldg., Providence, R. I.

Please put me on the list to receive all reports on Assembly Savings with Phillips Screws

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Company .....

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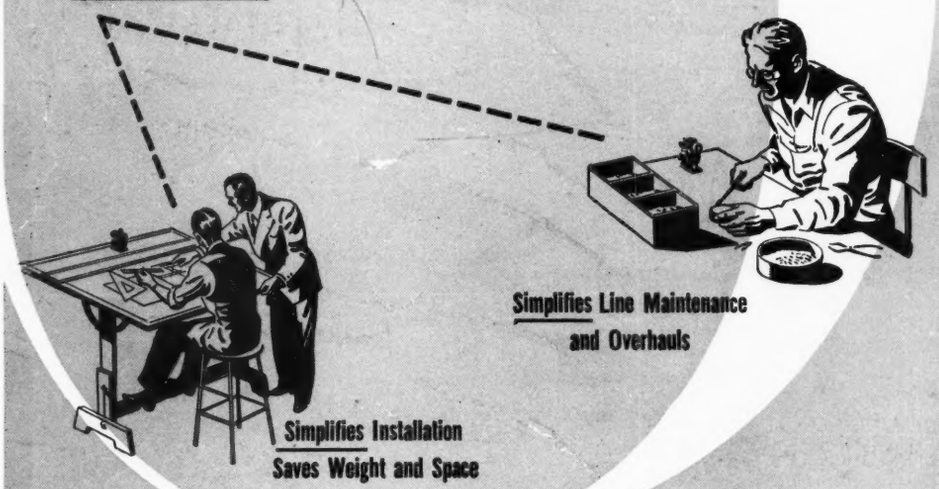
PIONEER MAGNESYNS

Simplify

Remote Indicating Problems



Simplifies Line Maintenance and Overhauls

Simplifies Installation Saves Weight and Space

That Pioneer* Magnesyns* provide today's most satisfactory form of remote indication is clearly shown by the fact that these small, lightweight units are standard equipment on all major airlines. Ruggedly constructed, they can be mounted solidly to the engine thereby eliminating the need for shock mounting.

Since they transmit their indications *electrically* they avoid the use of complicated flexible lines, thus saving weight and space. Cold weather operational difficulties are also eliminated—installation is very simple, and quick changing of either transmitter or indicator is possible. Find out more about how these instruments can save weight and space in your designs.

*REG. U. S. PAT. OFF.

Pioneer Instruments

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TETERBORO, NEW JERSEY

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